APPENDIX A

VOLUME I

SUPPLEMENTAL INVESTIGATION

INSTALLATION RESTORATION PROGRAM ACTIVITIES

NAVAL STATION ROOSEVELT ROADS CEIBA, PUERTO RICO

CONTRACT TASK ORDER 0007

APRIL 29, 1994

Prepared For:

DEPARTMENT OF THE NAVY
ATLANTIC DIVISION
NAVAL FACILITIES
ENGINEERING COMMAND
Norfolk, Virginia

Under the:

LANTDIV CLEAN Program
Contract N62470-89-D-4814

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EXECUTIVE SUMMARY

This report presents the information developed by the Supplemental Investigation of certain sites at Naval Station, Roosevelt Roads, Ceiba, Puerto Rico (NSRR). The subject sites are:

Site 1 - Quebrada Disposal Site, Vieques Island
Site 2 - Mangrove Disposal Site, Vieques Island
Site 5 - Army Cremator Disposal Area
Site 6 - Langley Drive Disposal Area
Site 7 - Station Landfill
Site 10 - Building 25 Storage Area
Site 13 - Tanks 210-217
Site 14 - Ensenada Honda Shoreline and Mangroves
Site 16 - Old Power Plant, Building 38
Site 18 - Building 128, Pest Control Shop and Surrounding Area
Site 21 - Building 121, Old Pesticide Storage

Sites 1 and 2 are on the Naval Ammunition Facility, Vieques Island (NAF-V). The remaining sites are all on NSRR main base.

This Supplemental Investigation of environmental conditions at these sites augments the Installation Restoration Program (IRP) activities for these sites under the Naval Engineering Facilities Command (NAVFACENGCOM), Atlantic Division (LANTDIV) Contract Number N62470-89-4814, Contract Task Order 0007 (CTO-0007), dated 7 November 1991 and amended by LANTDIV.

1.0 OBJECTIVES

The objectives of the Supplemental Investigation are:

1. Verify the data collected during the Confirmation Study (CS) by developing a defensible database.

2. Collect limited data for preparation of a RCRA Facilities Investigation (RFI) at certain sites.

3. Provide usable and defensible data for the RFI.

2.0 RECOMMENDATIONS

The recommendations of the Supplemental Investigation, following from the conclusions and observations, are that further investigation or remediation of any site should not be undertaken. The justifications for these recommendations rest on the acceptably low levels of apparent risk quantified

The subject sites of the Supplemental Investigation should be relieved of an RFI.

3.0 CONCLUSIONS

The relevant findings, presented as the conclusions of the Supplemental Investigation, are:

Adequate information is available for characterization of Sites 1, 2, 5, 6, 10, 14 and 18.

Further investigations of site conditions are unnecessary, considering the absence of risk calculated from the available information.

These conclusions and recommendations refer mainly to the Sites 1, 2, 5, 6, 10, 14 and 18 which are under review for design of an RFI. The information for the remaining Sites 7, 13, 16 and 21 has, according to the provisions of the project plans, been prepared for submission, or has been submitted to the programs relevant to those sites.

The general description of the relevant sites involves review of the significant characteristics of topography, hydrology, physical and chemical geohydrology, and operational considerations.

3.1 Topography

The following summaries have been prepared from the information obtained from literature, drawings and site investigations:

Site 1: The disposal material is randomly scattered and entirely exposed at the surface, and that the overgrowth of low vegetation is exceptionally dense.

Site 2: The disposal material is sparsely and randomly scattered, and is entirely exposed at the surface.

Site 5: The disposal material is mostly buried, with some scattering at the surface and with some material protruding from the ground; the overgrowth of vegetation is exceptionally dense.

Site 6: The disposal material is mostly buried in the shallow soil with some scattering at the surface, and that the overgrowth of vegetation is exceptionally dense.

Site 7: Site 7 - Station Landfill lies on the peninsula east of the harbor. The area is largely level and cleared, except for low brush across the inactive parts and for large trees with dense undergrowth on the harbor shoreline on the west side of the operating area. The landfill in slightly elevated above the harbor, and includes the spine of the peninsula (with the land surface apparently falling away to the west, south and east).

Site 10: The surface area of Site 10 is extensively reworked by construction and base operations. No distinct features of Building 25 remain except the foundation pad on which heavy equipment is now occasionally parked.

Site 13: Tanks 210-217 include three underground fueling facilities on the perimeter of the mangrove swamp on the east side of the NSRR. Each (tank farm) facility lies in a clearing on a shallow hillside with no other operations adjacent.

Site 14: Site 14 is a coastal margin containing a mangrove swamp.

Site 16: Site 16 lies at the north (landward) end of the peninsula containing Site 7.

Site 18: The immediate vicinity of Building 128 is cleared and approximately level, with a hardstand occupying about half of the site.

Site 21: Building 121 sits on a hillside above Site 10 and below the Station Hospital. The abandoned building is surrounded by a moderately dense growth of trees, with an access road cut to a main road leading off Antietam Road to the Public Works Building.

3.2 Hydrology

The hydrology of each site is characteristic of the terrain. The topographic expression of each site varies the dominant hydraulic characteristic from marine waters to standing pools to intermittent streams.

Site 1: The bottom of the ravine (quebrada) below the disposal material was found to be dry during the field program. The appearance of the streambed indicated that no flowing water could be expected outside a period of intense precipitation; the light to heavy precipitation experienced during the field program did not produce a continuous flow in the ravine (even during and shortly after storms). Therefore, the flow of surface water can be largely neglected in considering further action at this site; only the steepness of the ravine profile would be of concern as a control on overland movement of liquids and solids.

Site 2: The low-lying disposal area is surrounded on three sides by open water. There are abundant indications in the field that the site is flooded frequently. This flooding can be expected to effect some additional dispersal of materials at the site.

Site 5: There are no established streams within Site 5. The dominant hydrologic feature associated with the site is the mangrove swamp of Site 14.

Site 6: There are no established streams within Site 6. The dominant hydrologic feature associated with the site is the mangrove swamp of Site 14.

Site 7: There are no established streams at Site 7. There is minor ponding of water following rains, but the dominant hydraulic influences are the adjacent marine waters.

Site 10: There are no surface streams at Site 10. There is some internal drainage to the north and northeast side of the site, in a vegetated area.

Site 13: There are no established streams at Site 13. The dominant hydraulic control is the adjacent mangrove swamp.

Site 14: The hydrologic regime of Site 14 is controlled by the semidiurnal tides, embayment circulation and response to storms by oceanic waters in the harbor.

Site 16: There are no established streams at Site 16. There is minor ponding of water following rains, but the dominant hydraulic influences are the adjacent marine waters.

Site 18: The significant hydrologic features of Site 18 are a drainage ditch paralleling Forrestal Drive and a wetland west of the site.

Site 21: There are no significant hydrologic features associated with Site 21.

3.3 Physical Geohydrology

Site 1: The three wells at the site were found and examined. No immediate need for repair was noted. The significant findings and observations on the groundwater monitoring system are: The general elevation of the water-table had dropped sufficiently since installation of the wells that no usable water could be found in the wells; and the configuration of the stations in relation to the disposal material indicates that the wells are displaced downslope from the most notable area of debris, and that the wells are appropriately placed downgradient of the disposal material (field observations also indicate that no other positions in the area would provide significantly better advantage for monitoring the water table).

Site 2: The hydrologic system of the disposal area is entirely controlled by the surrounding, tidal surface waters.

Site 5: Insufficient data are available for a conclusive discussion of the geohydrology of Site 5 (Section 6.1.1.3).

Site 6: Insufficient data are available for discussion of the geohydrology of Site 6 (Section 6.1.1.4).

Site 7: The geohydrologic information for Site 7 is being submitted to the relevant program.

Site 10: The geohydrology of Site 10 was not addressed (Section 6.1.1.5).

Site 13: Assessment of the groundwater regime at Site 13 was not part of the field program.

Site 14: The geohydrology of Site 14 is not relevant (Section 6.1.1.6) because of the marine environment of the mangrove swamp.

Site 16: Assessment of the groundwater regime at Site 16 was not part of the field program.

Site 18: The water-table is shallow, at about three to nine feet below ground. The near-surface flow is to the west, through colluvial material having hydraulic conductivities ranging from about 0.14 to 1.3 ft/d.

Site 21: Assessment of the groundwater regime at Site 21 was not part of the field program.

3.4 Chemical Geohydrology

Site 1: Analysis of inorganic parameters indicates no distinctly abnormal concentrations in any medium. Synthetic organic compounds are present at the site in all media tested; however, the concentrations found do not indicate that these compounds are of significant environmental interest.

Site 2: Analysis of inorganic parameters indicates no distinctly abnormal concentrations in any medium. Synthetic organic compounds are present at the site in all media tested; however, the concentrations found do not indicate that these compounds are of significant environmental interest. The analyses of disposal material (tar or asphaltic oil) did not indicate a dominant environmental influence by that material.

Site 5: The single data station found at Site 5 provides information on background conditions only. Nothing significant appears in these data, except the general appearance across the station of pesticides.

Site 6: The single data station at Site 6 provides information on background conditions only. Nothing significant appears in these data.

Site 7: The geohydrologic information for Site 7 is being submitted to the relevant program.

Site 10: The geohydrology of Site 10 was not addressed (Section 6.1.1.5).

Site 13: Assessment of the groundwater regime at Site 13 was not part of the field program.

Site 14: The geohydrology of Site 14 is not relevant (Section 6.1.1.6) since it is in a marine environment.

Site 16: Assessment of the groundwater regime at Site 16 was not part of the field program.

Site 18: The results of analyses of inorganic compounds do not indicate an impression of dissolved species on the expectable groundwater quality. The results of analyses of organic compounds similarly indicate no general distribution of those compounds in the groundwater. There is a minor presence of pesticide in the soil, surface water and sediment of Site 18.

Site 21: Assessment of the groundwater regime at Site 21 was not part of the field program.

3.5 Operational Considerations

Site 1: Site 1 is characterized (1) by steep slopes of the ravine walls and a steep profile of the (normally dry) streambed in the ravine, and (2) by an exceptionally dense overgrowth of low vegetation. These conditions make effective movement around the site impossible without extensive land-clearing. Further mapping of the site, and any further investigation or remedial action at the site, would unavoidably involve extensive land-clearing in highly unfavorable terrain. Extensive land-clearing, given the surface-scattering of debris, would necessarily include displacement of virtually all of the remaining debris, requiring disposal under a regulated program. An endangered/protected species of insect occupies this area; land-clearing of usable proportions could not proceed without a detailed survey of the nests of these insects and relocation of those nests.

Site 2: The area is moderately vegetated; further investigation can be conducted with minimal disturbance of this cover, but remedial actions would require land-clearing and revegetation. The disposal material is scattered across the surface of small areas, and relatively accessible.

Site 5: Site 5 is characterized (1) by steep slopes on the sides of the knoll, and (2) by an exceptionally dense overgrowth of low vegetation. These conditions make effective movement around the site impossible without extensive land-clearing, effectively of the entire knoll. Further mapping of the site, and any further investigation or remedial action at the site, would necessarily involve extensive land-clearing in unfavorable terrain. Extensive land-

clearing, given the surface-scattering of some debris, would include displacement of those debris, requiring disposal under a regulated program. Land-clearing on an appropriate scale would also involve extensive siltation in the nearby, protected environment of the mangrove swamp.

Site 6: Site 6 is characterized by an exceptionally dense overgrowth of low vegetation on boggy ground. This makes effective movement around the site impossible without extensive landclearing, effectively of the entire margin between the road and the inundated perimeter of the mangrove swamp. Further mapping of the site, and any further investigation or remedial action at the site, would necessarily involve extensive land-clearing in highly unfavorable terrain. Extensive land-clearing, given the shallow burial and surface-scattering of debris, would unavoidably include displacement of those debris, requiring disposal under a regulated program. Land-clearing on an appropriate scale would also involve extensive siltation in the nearby, protected environment of the mangrove swamp.

Site 7: No relevant comments.

Site 10: The current use of the land-surface of Site 10 indicates that further investigation or any remedial action would disrupt base support operations extensively. Further investigation of the area around Building 25 would yield results that could not be defensibly associated with operations at Building 25, given the extent of current activities.

Site 13: No relevant comments.

Site 14: There are no feasible remedial actions applicable to Site 14, except monitoring of natural processes.

Site 16: No relevant comments.

Site 18: Site 18 is open to investigation and remedial operations between the tree-line and Forrestal Drive. Operations beyond the tree-line would require extensive land-clearing.

Site 21: No relevant comments.

3.6 Contaminant Distribution

Disposal materials are exposed at Sites 1, 2, 5 and 6; however, there is no strong evidence that an outfall of contaminant constituents has migrated from the disposal materials in any examined medium. Disposal materials are not apparent at Sites 10, 14 and 18; also, there is no strong evidence that an outfall of contaminant constituents has migrated from the expected disposal areas in any examined medium.

3.7 Risk Evaluation

The overall findings of the risk evaluation were that none of Sites 1, 2, 5, 6, 10, 14 and 18 presents an identifiable risk to a sensitive receptor, according to the concentrations of contaminant constituents and the availability of those constituents.

4.0 DISPOSITION OF SITES AND CATEGORIES OF INVESTIGATION

Of the subject sites, varying disposition was planned following this Supplemental Investigation. Sites 1, 2, 5, 6, 10, 14 and 18 were expected to enter some form of negotiation with Region II of the Environmental Protection Agency (EPA-II) for the prosecution of an RFI to complete the IRP activities for those sites; Site 13 was expected, as a result of the photo-interpretation not revealing the previous existence of disposal pits, to be released from the RFI to the UST program. The information from Sites 7, 16 and 21 would be turned over to other, ongoing programs.

Given the variation in intentions for the subject sites and the variations in characteristics, differing analytical matrices and sequences were selected for individual sites. The matrices and sequences of an individual site reflect the expected disposition of that site.

The analytical sequences for each matrix, regardless of site, included: VOC - volatile organic compounds of the Target Compound List (TCL); SVOC - semivolatile organic compounds of the TCL; P/PCB - pesticide and polychlorinated biphenyl compounds of the TCL; TAL - metals and cyanide of the Target Analyte List. Quality control of analyses was specified at NEESA Level D, equivalent to CLP procedures at EPA Level 4.

5.0 TECHNICAL INVESTIGATIONS AND SUPPORT ACTIVITIES

The studies for the Supplemental Investigation fell into the following major categories: Photo-interpretation and map analysis; geophysical investigation; well-head tests; representation of groundwater flow; and sampling and analysis. The main support for the technical investigations comprised: Land navigation; surveying; land-clearing; computer mapping; and correlation of analytical data.

5.1 Photo-Interpretation

The interpretation of historical aerial photographs had varying usefulness for the Supplemental Investigation. The most valuable contribution of the photo-interpretation appeared for Sites 5, 6 and 13: The previously undefined areas of disposal at Sites 5 and 6 were identified with remarkable precision for the field investigation; the absence of indications of disposal at Site 13 should allow reversion of that site to the UST program.

Correlation between the disposal features noted by the photo-interpretation and the disposal indications found during landclearing is very high. The field evidence indicates a very high confidence that the data stations at Sites 5 and 6 are properly sited in relation (within and downslope) to the disposal features.

5.2 Geophysical Survey

The geophysical surveys were conducted after land-clearing had exposed areas indicated by the photo-interpretation to have been part of the disposal operation at Site 5; no other sites were examined by geophysical methods. These surveys involved: (1) EM (electromagnetic terrain conductivity) mapping of contrasts in subsurface material that indicated artificial boundaries, such as trench walls, associated with disposal practices; and, (2) MAG (total field magnetic) mapping of subsurface metallic objects, usually associated with disposal. The traverses followed the access lanes along orientations selected following review of the photo-interpretation and map analysis, and according to examination of the exposed parts of the lanes as they were advanced.

5.3 Physical Geohydrology

The wells at Site 1 were found dry during the field program. Of the wells at Site 5 indicated in the Work Plan for measurement, only 05GW01 could be found. Only 06GW01 exists at Site 6. All eight of the wells at Site 7 were accessible. The use of wells at Site 10 was not included in the field program. All three of the wells at Site 18 were accessible.

Groundwater contour maps cannot be prepared for Sites 1, 5 and 6 due to insufficient distribution of data stations. A groundwater contour map cannot be prepared for Site 7 due to the radial nature of flow associated with the peninsula on which it is placed. The groundwater data for Site 18 are recorded on Table 4-1.

The values for hydraulic conductivity were calculated values for all wells at Sites 5, 6, 7 and 18. The range of values is from about 0.1 to 2.2 ft/d, expectable for this geologic terrane.

5.4 Chemical Geohydrology

Examination of the chemical quality of soils, sediments, surface water and groundwater (with structural and disposal materials) involved measurement of the field parameters for groundwater (pH - chemical activity of ionic hydrogen; Sc - specific conductance; and T - temperature) and detailed laboratory analyses for all media.

The higher readings of Sc (at all stations except 18GW03) reflect the relative influence of brackish or saline water at the coastal margin (near a shoreline or near the inland edge of a mangrove swamp). The reading of 1000 millimhos/centimeter at 18GW03 is within the range of freshwater with very high TDS (total dissolved solids). The readings of pH and T are unremarkable.

For the sites expected to enter negotiation for an RFI, the results of laboratory analyses indicated that all inorganic parameters (TAL metals and cyanide) were within expectable ranges for natural conditions. These results also indicated the presence of organic compounds (VOC, SVOC and P/PCB) in certain media; these compounds appeared in generally low concentrations.

Evaluation of the data available from this Supplemental Investigation against the data available from the Confirmation Study indicates that the CS data reliably represent

conditions at the subject sites. The data from the CS can then be used appropriately in the evaluation of the disposition of each site, and support the recommended relief from further investigation or remedial action.

6.0 RISK TO HUMAN HEALTH AND THE ENVIRONMENT

Current and future (potential) risks were calculated from the available data in the most reasonably conservative fashion for each of Sites 1, 2, 5, 6, 10, 14 and 18. The chemicals of concern, as the contaminants detected having a significant potential effect on human health and the environment, were identified for each site. The exposure and toxicity assessments addressing the distributions and concentrations of contaminants represented the availability of these compounds to the sensitive receptor. The risks were calculated by standard means of quantification for each site; the internal criticisms of these means were made.

The overall findings of the risk evaluation were that none of Sites 1, 2, 5, 6, 10, 14 and 18 presents an identifiable risk to a sensitive receptor, according to the concentrations of contaminant constituents and the availability of those constituents. The data and analyses were found valid.

1.0 INTRODUCTION

1.1 Purpose of the Supplemental Investigation

The Supplemental Investigation was designed to augment the regulatory programs, particularly the Installation Restoration Program (IRP), at Naval Station, Roosevelt Roads (NSRR) (Figures 1-1 and 1-2), presenting recommendations and conclusions on the proposed fate of some sites. This information will enable LANTDIV and the Activity to prepare their environmental strategy and plan for future regulatory compliance measures. This augmentation is necessary since the most recent available information is from the Confirmation Study (Section 1.3), whose data were collected in February 1987.

Although the Confirmation Study is part of the regulatory programs for NSRR, the information obtained during the Supplementary Investigation and presented in this report is not a formal part or requirement of those programs. It is likely, however, that the information presented in this report may be used in future environmental activities and reports, possibly a RCRA Facilities Investigation (RFI).

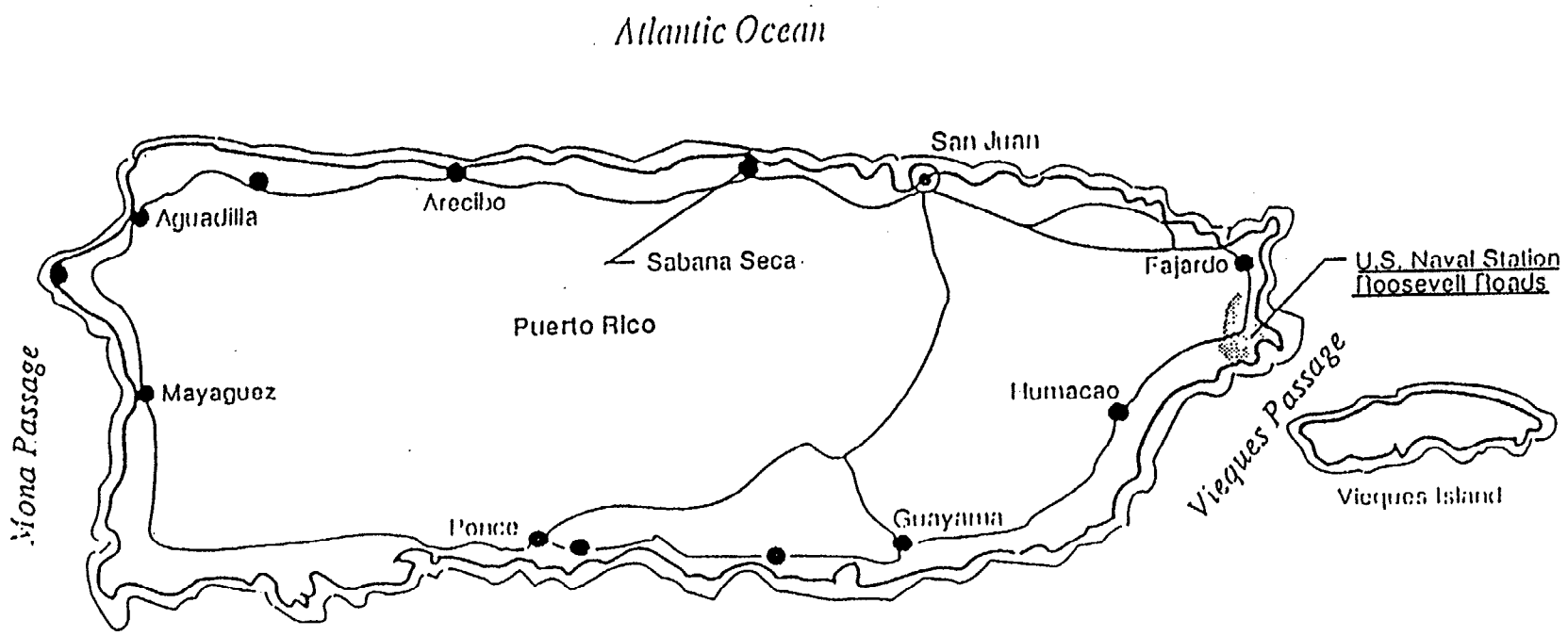
1.1.1 Objectives

The objectives of the Supplemental Investigation are:

1. Verify the data collected during the Confirmation Study (CS) by developing a defensible database;

2. Collect limited data for preparation of a RCRA Facilities Investigation (RFI) at certain sites; and,

3. Provide usable and defensible data for the RFI.



Baker

Baker Environmental, Inc.

FIGURE 1-1
LOCATION OF U.S. NAVAL STATION
ROOSEVELT ROADS, PUERTO RICO

00702830

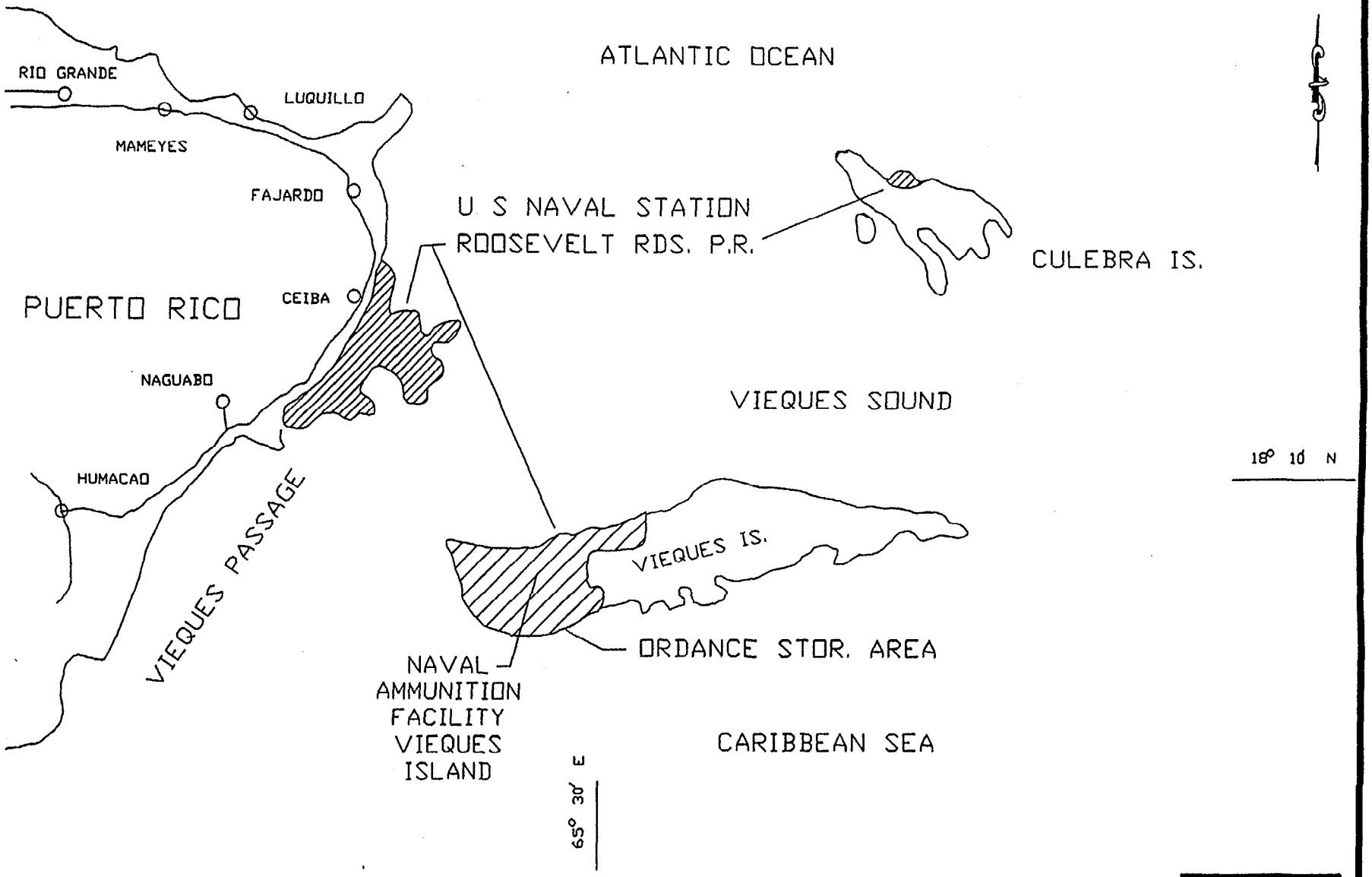


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FIGURE 1-2
AREA MAP OF U.S. NAVAL STATION
ROOSEVELT ROADS, P.R. AND
VIEQUES ISLAND

00702930

1.1.2 Categorization of Sites

This report presents the information developed by the Supplemental Investigation of certain sites at NSRR. The subject sites (Section 1.2.3.4) are:

Site 1 - Quebrada Disposal Site, Vieques Island
Site 2 - Mangrove Disposal Site, Vieques Island
Site 5 - Army Cremator Disposal Area
Site 6 - Langley Drive Disposal Area
Site 7 - Station Landfill
Site 10 - Building 25 Storage Area
Site 13 - Tanks 210-217
Site 14 - Ensenada Honda Shoreline and Mangroves
Site 16 - Old Power Plant, Building 38
Site 18 - Building 128, Pest Control Shop and Surrounding Area
Site 21 - Building 121, Old Pesticide Storage

Sites 1 and 2, at the Naval Ammunition Facility, Vieques Island (NAF-V), are generally located on Figure 1-3, and schematically depicted on Figures 1-4 and 1-5, respectively. The remaining sites, all on NSRR main base, are indicated on Figure 1-6, and diagramed on Figures 1-7 through 1-15.

These sites and the Supplemental Investigation of environmental conditions at these sites are part of the Installation Restoration Program (IRP) activities under the Naval Engineering Facilities Command (NAVFACENGCOM), Atlantic Division (LANTDIV) Contract Number N62470-89-4814, Contract Task Order 0007 (CTO-0007), dated 7 November 1991 and amended variously by LANTDIV.

Of these sites, varying disposition was planned following this Supplemental Investigation. Sites 1, 2, 5, 6, 10, 14 and 18 were expected to enter some form of negotiation with Region II of the Environmental Protection Agency (EPA-II) for the prosecution of an RFI; Site 13 is expected, as a result of the photo-interpretation not revealing the previous existence of disposal pits, to be released from the RFI to the UST program. The information from Sites 7, 16 and 21 would be turned over to other, ongoing programs.

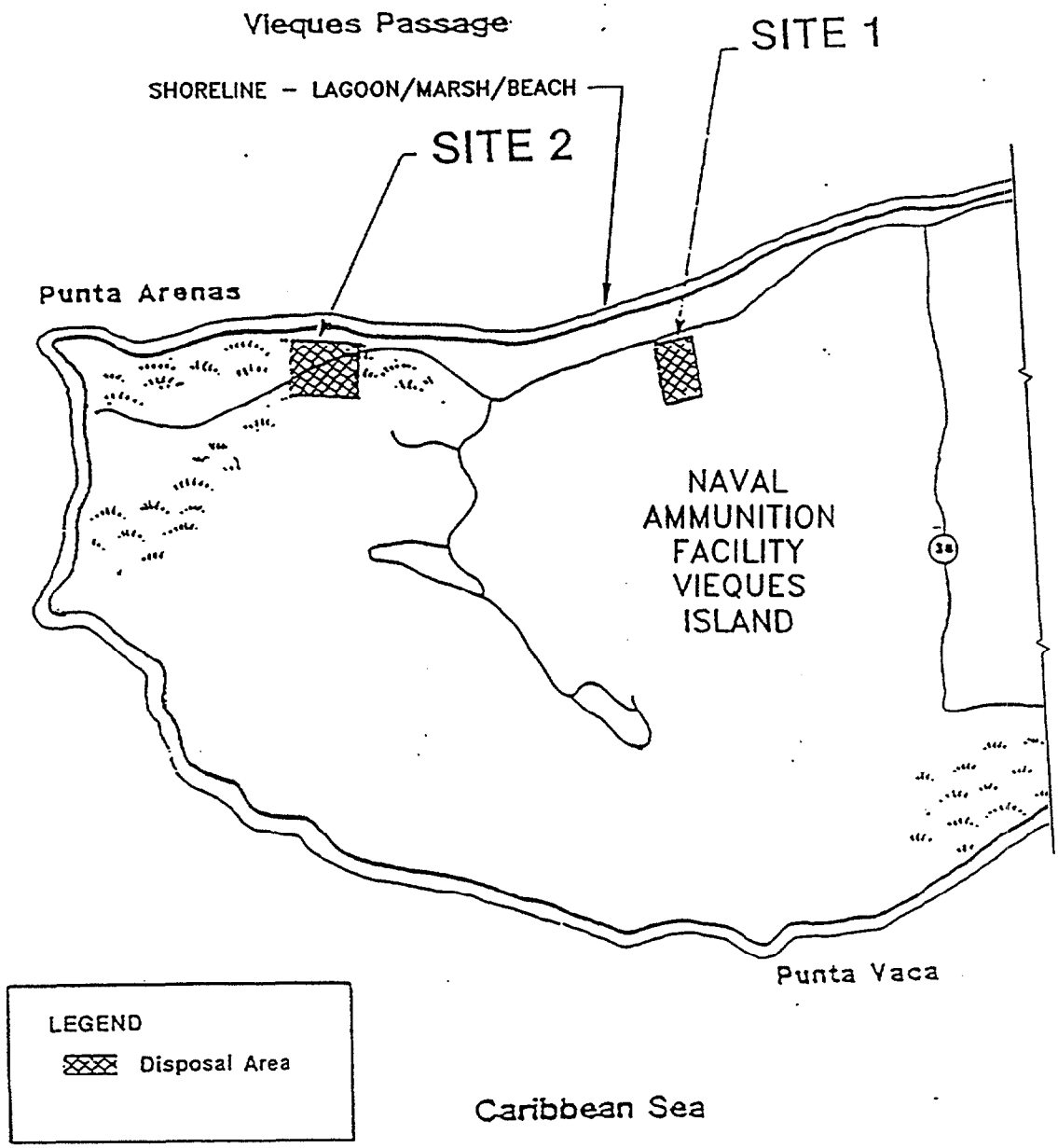
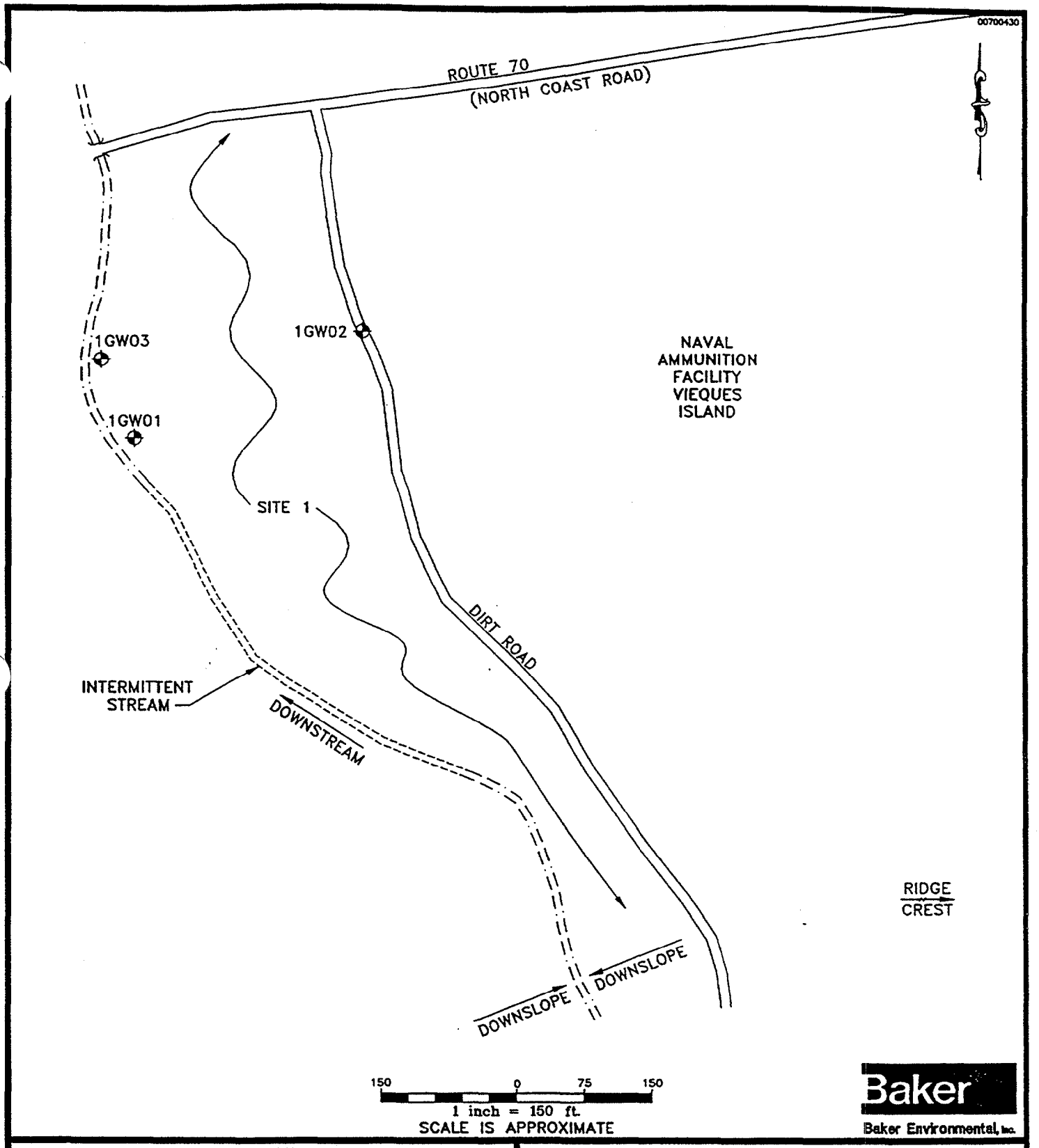


FIGURE 1–3
REGIONAL MAP
NAVAL AMMUNITION FACILITY, VIEQUES ISLAND
SITES 1 AND 2
NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

SOURCE: NEESA, 1984b; ESE, 1985.



LEGEND

1GW01 MONITORING WELL LOCATION

SOURCE: BAKER ENVIRONMENTAL GPS SURVEY, NOV. 1992

FIGURE 1-4
SCHEMATIC MAP
SITE 1
QUEBRADA DISPOSAL SITE
VEIQUES ISLAND
NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

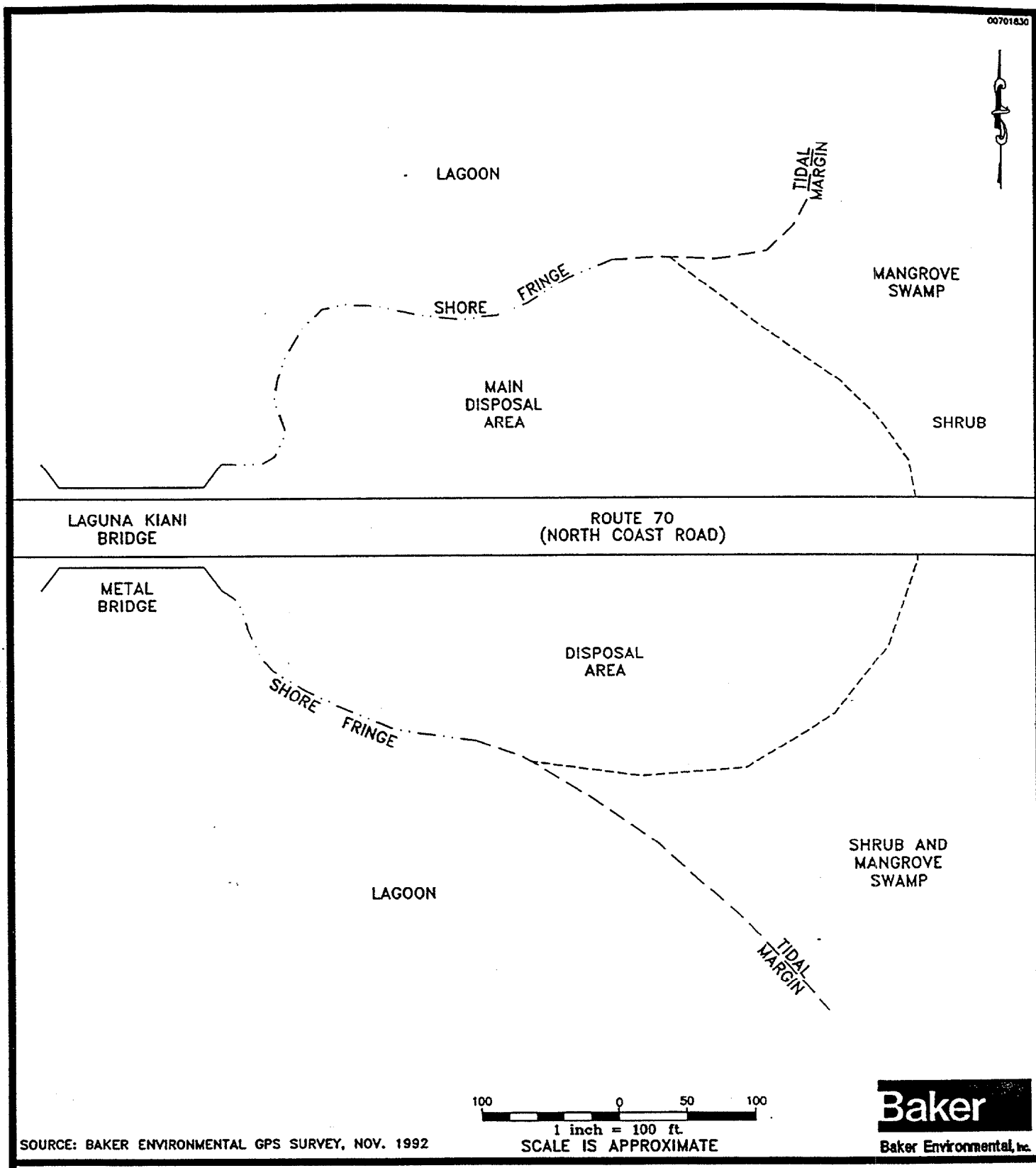


FIGURE 1-5
SCHEMATIC MAP
SITE 2
MANGROVE DISPOSAL SITE
VIEQUES ISLAND
NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

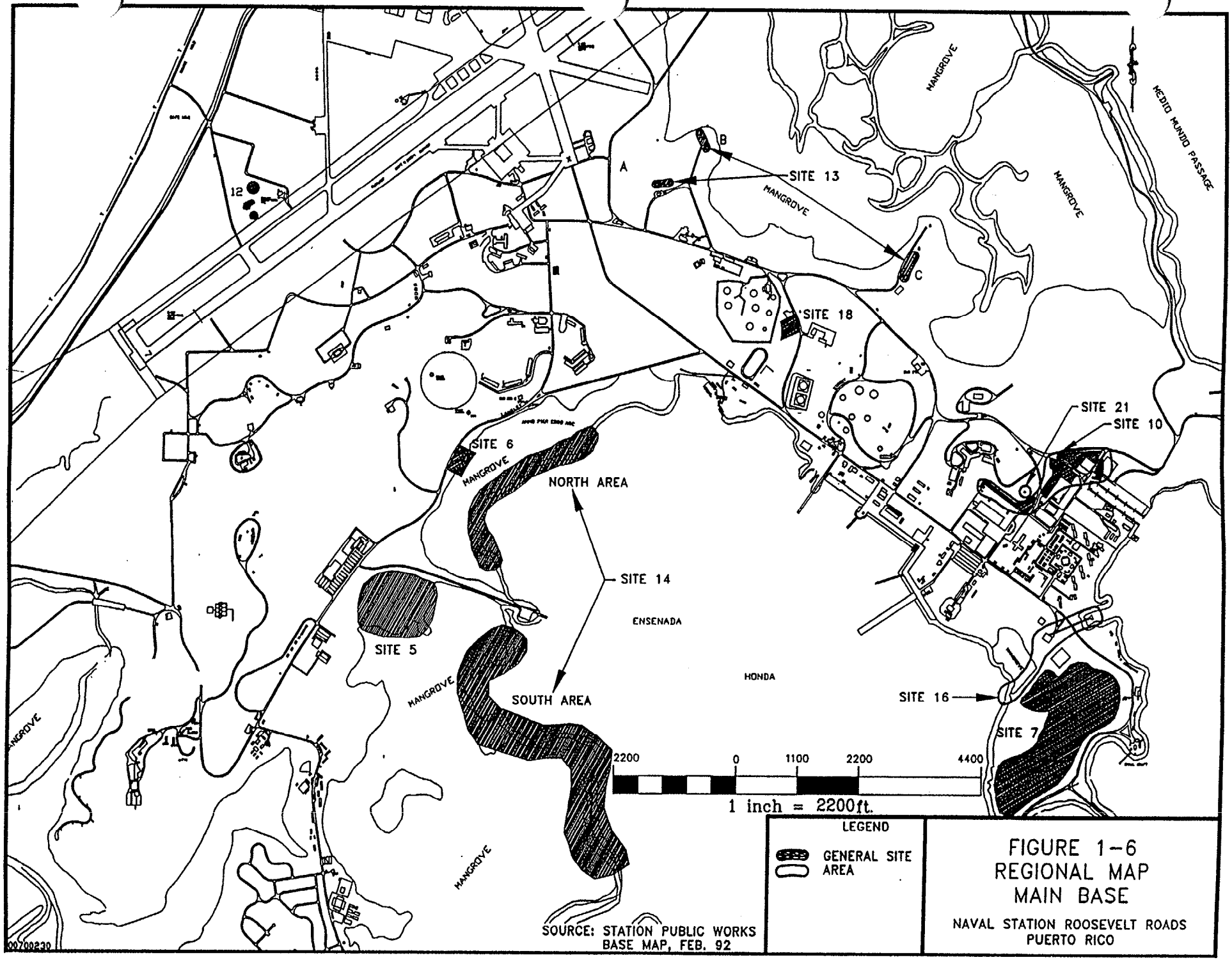


FIGURE 1-6
REGIONAL MAP
MAIN BASE

NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

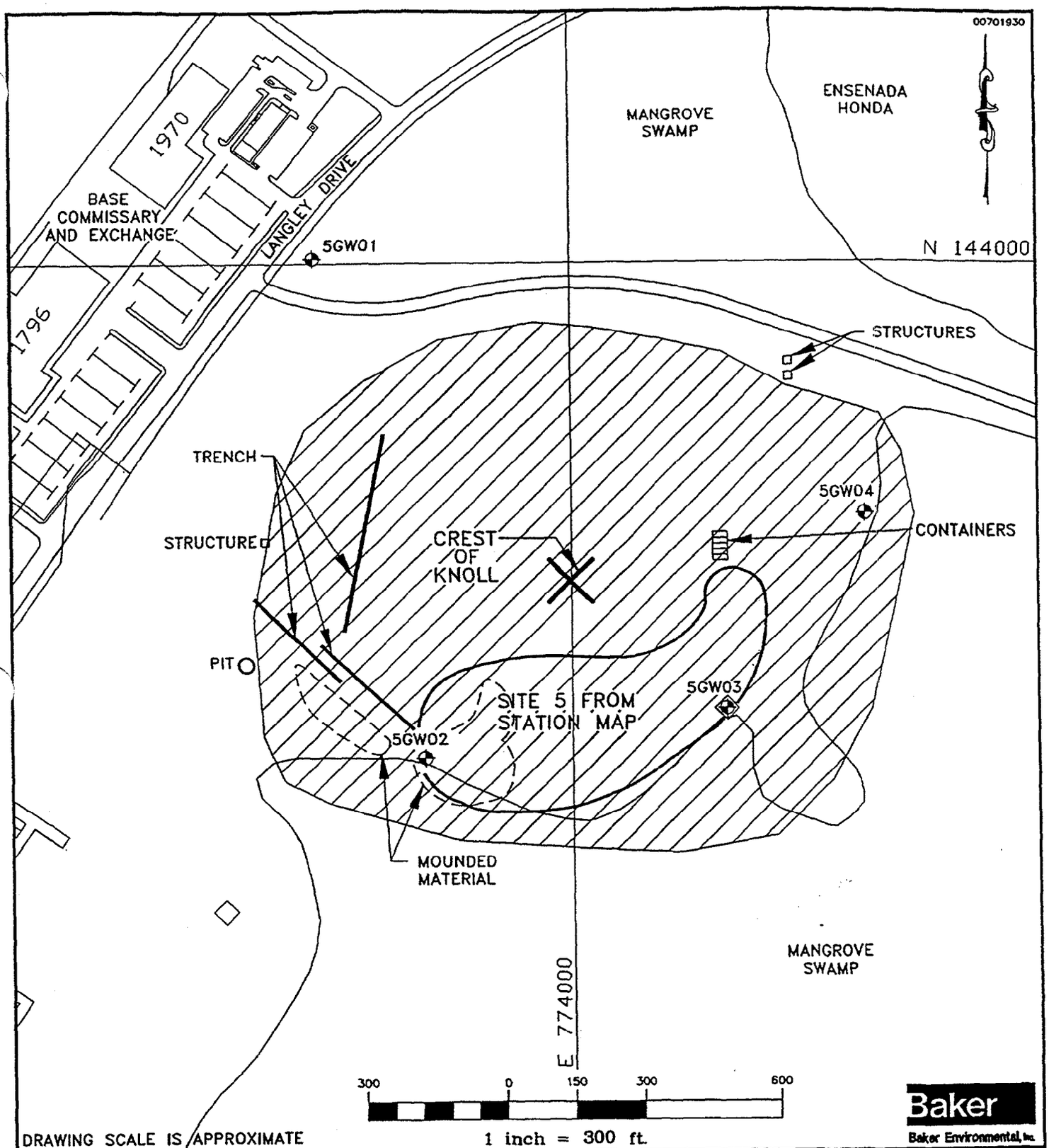
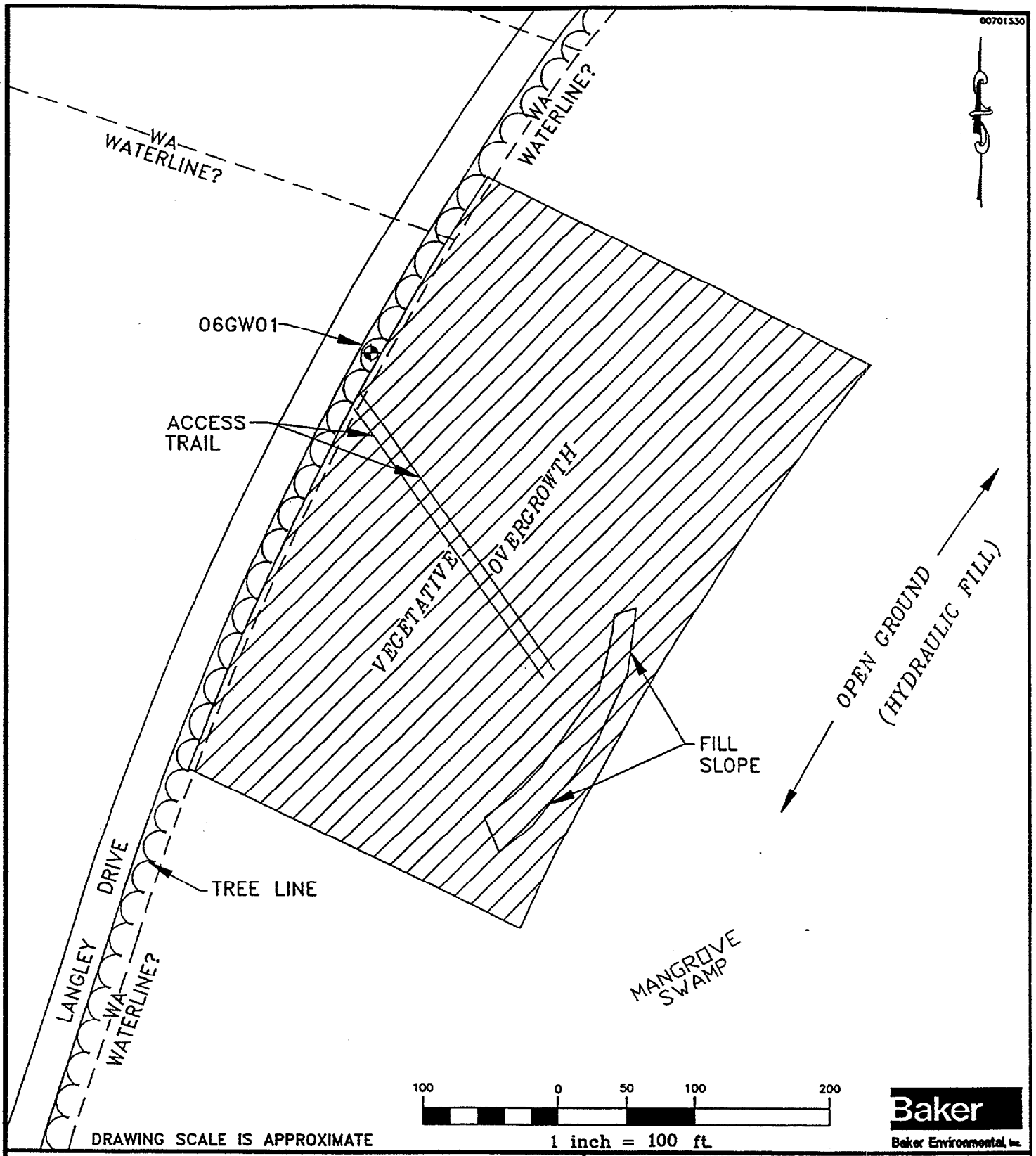


FIGURE 1-7
BASE MAP
SITE 5
ARMY CREMATOR DISPOSAL SITE
NAVAL STATION ROOSEVELT ROADS
PUERTO RICO



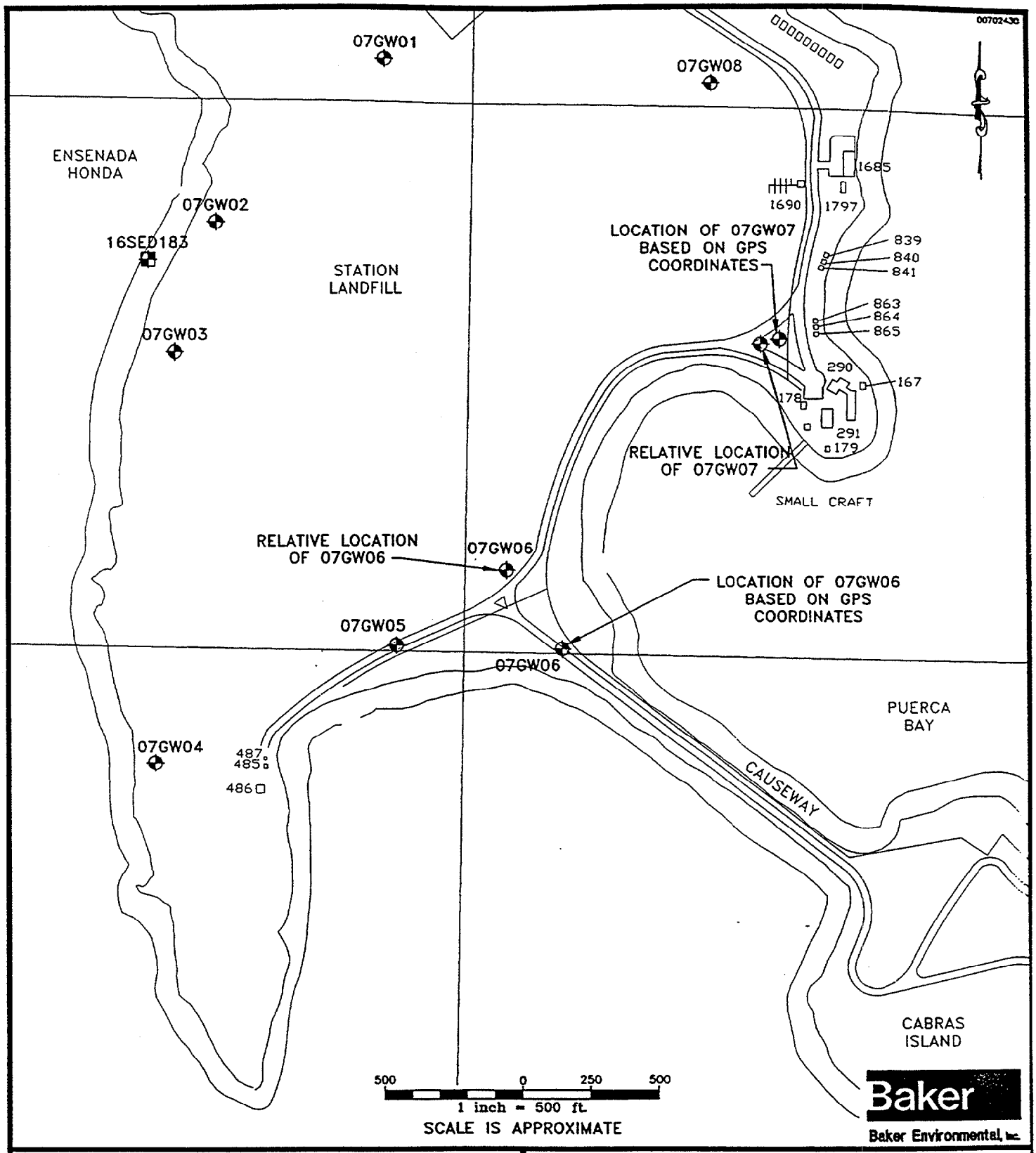
LEGEND

06GW01 ◆ MONITORING WELL LOCATION

NOTED FEATURES TRANSFERRED FROM AIR-PHOTO INTERPRETATION

SOURCE: STATION PUBLIC WORKS BASE MAP, FEB. 92

FIGURE 1-8
BASE MAP
SITE 6, LANGLEY DRIVE
DISPOSAL SITE
NAVAL STATION ROOSEVELT ROADS
PUERTO RICO



LEGEND

07GW01	MONITORING WELL LOCATION
16SED183	SURFACE WATER/SEDIMENT SAMPLE LOCATION
290	STATION STRUCTURE

SOURCE: STATION PUBLIC WORKS BASE MAP, FEB. 1992
SOURCE: BAKER ENVIRONMENTAL GPS SURVEY, NOV. 1992

FIGURE 1-9
BASE MAP
SITE 7
STATION LANDFILL

NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

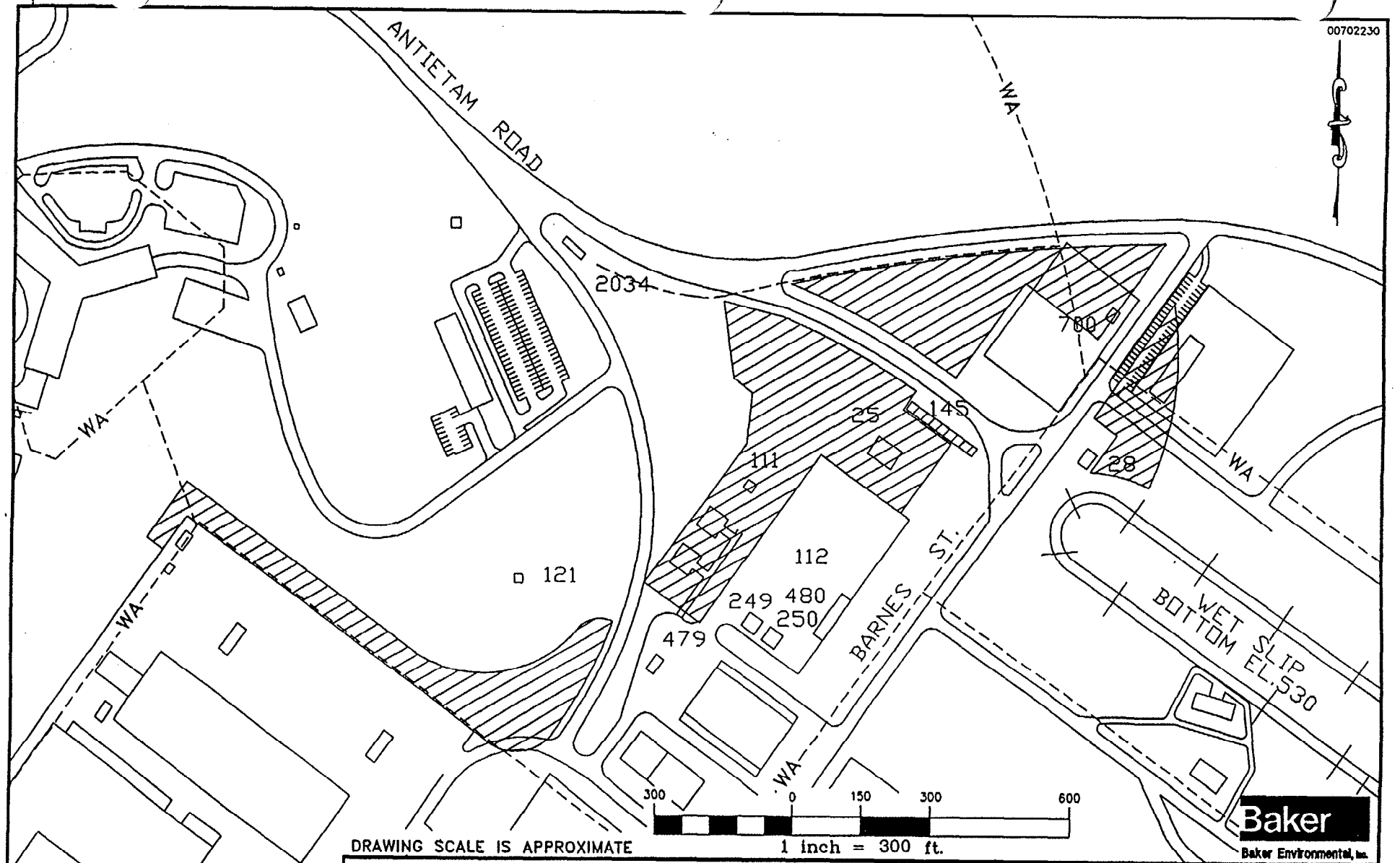
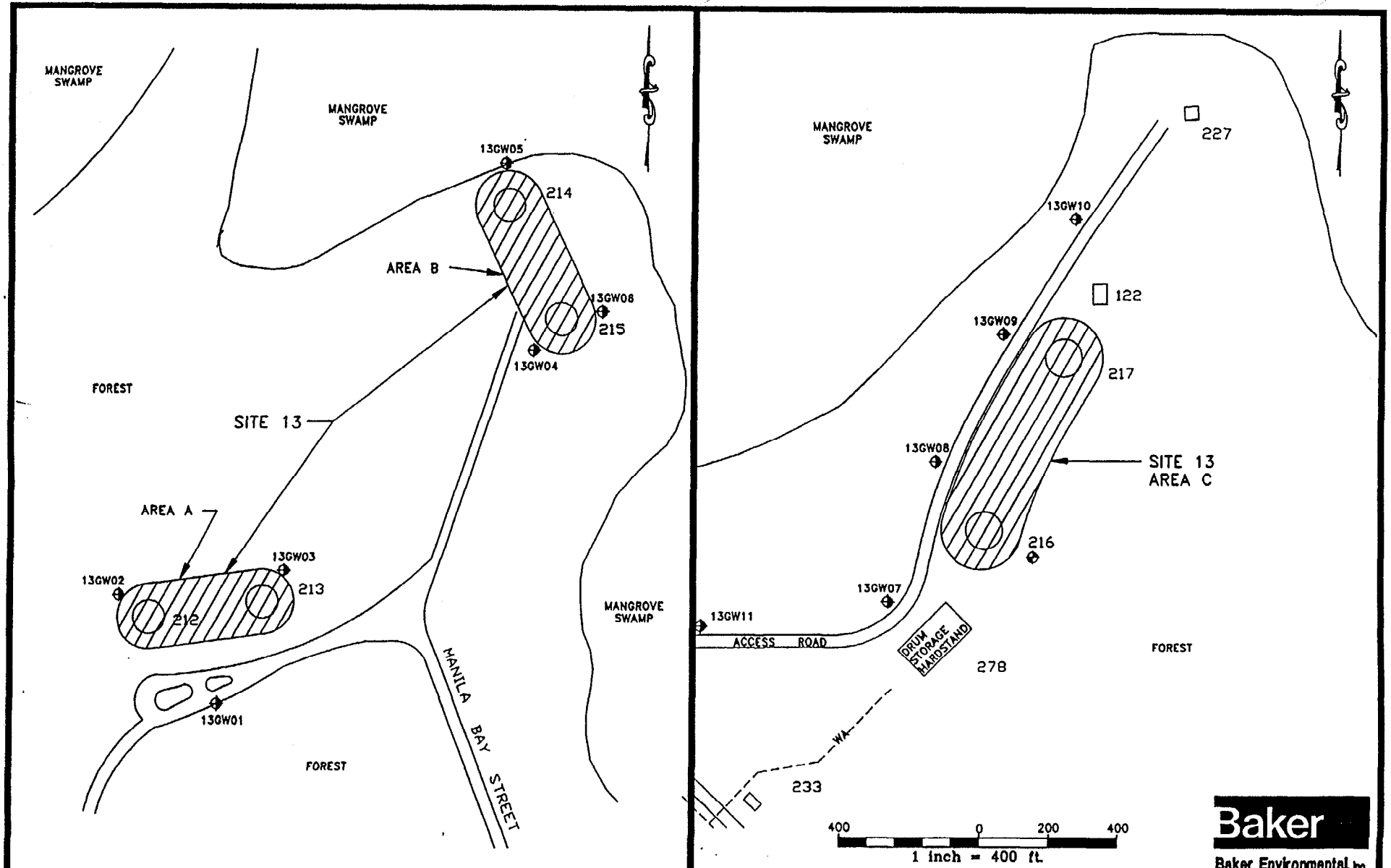


FIGURE 1-10
BASE MAP
SITE 10, BUILDING 25
STORAGE AREA

NAVAL STATION ROOSEVELT ROADS
PUERTO RICO



LEGEND

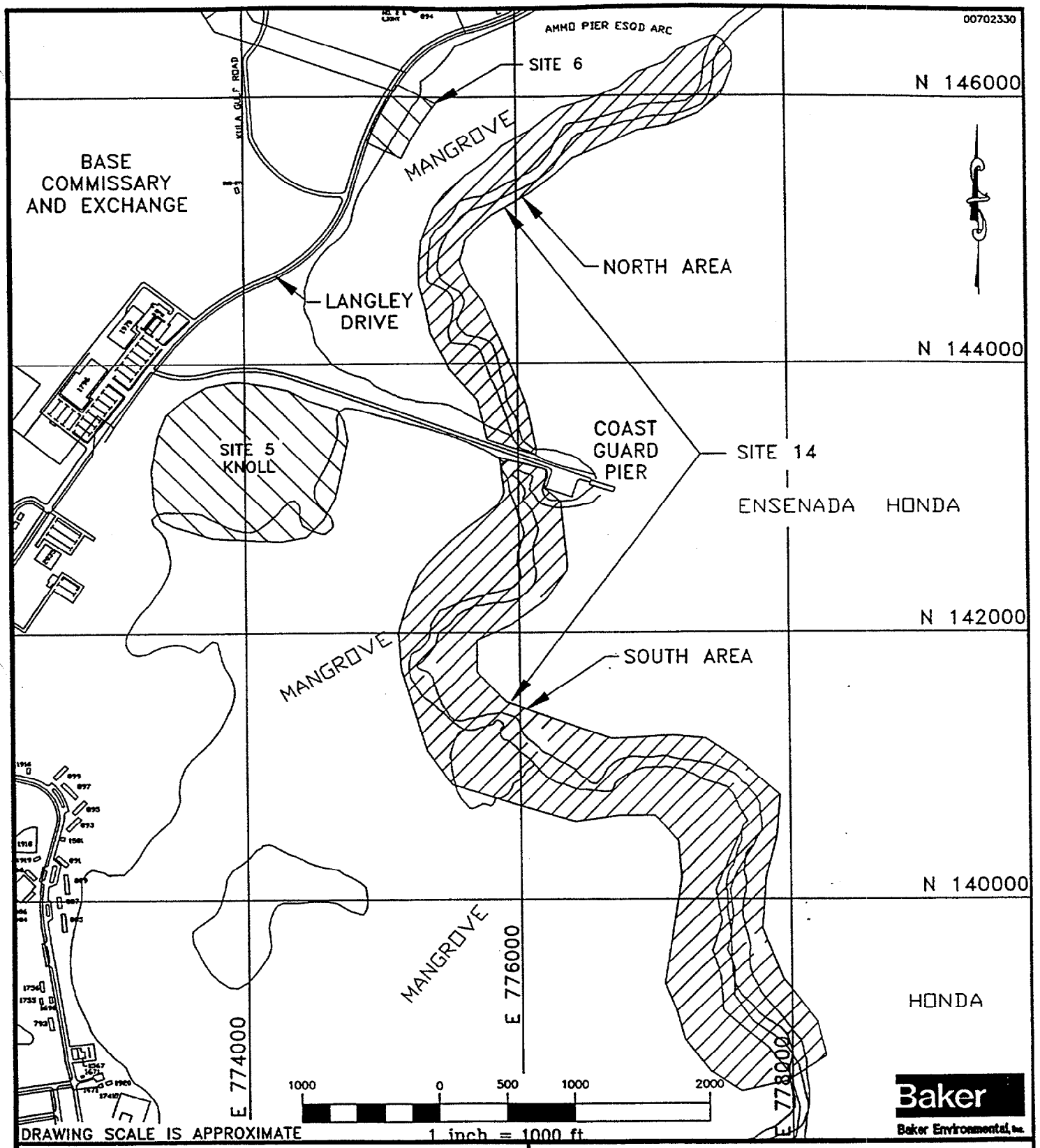
◆ MONITORING WELL LOCATION

233 □ STATION STRUCTURE

SOURCE: STATION PUBLIC WORKS BASE MAP, FEB. 92

00702630

FIGURE 1-11
BASE MAP
SITE 13
TANKS 210-217
NAVAL STATION ROOSEVELT ROADS
PUERTO RICO



LEGEND

1916 STATION STRUCTURE

SOURCE: STATION PUBLIC WORKS BASE MAP, FEB. 92

FIGURE 1-12
BASE MAP
SITE 14, ENSENADA HONDA
SHORELINE AND MANGROVES

NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

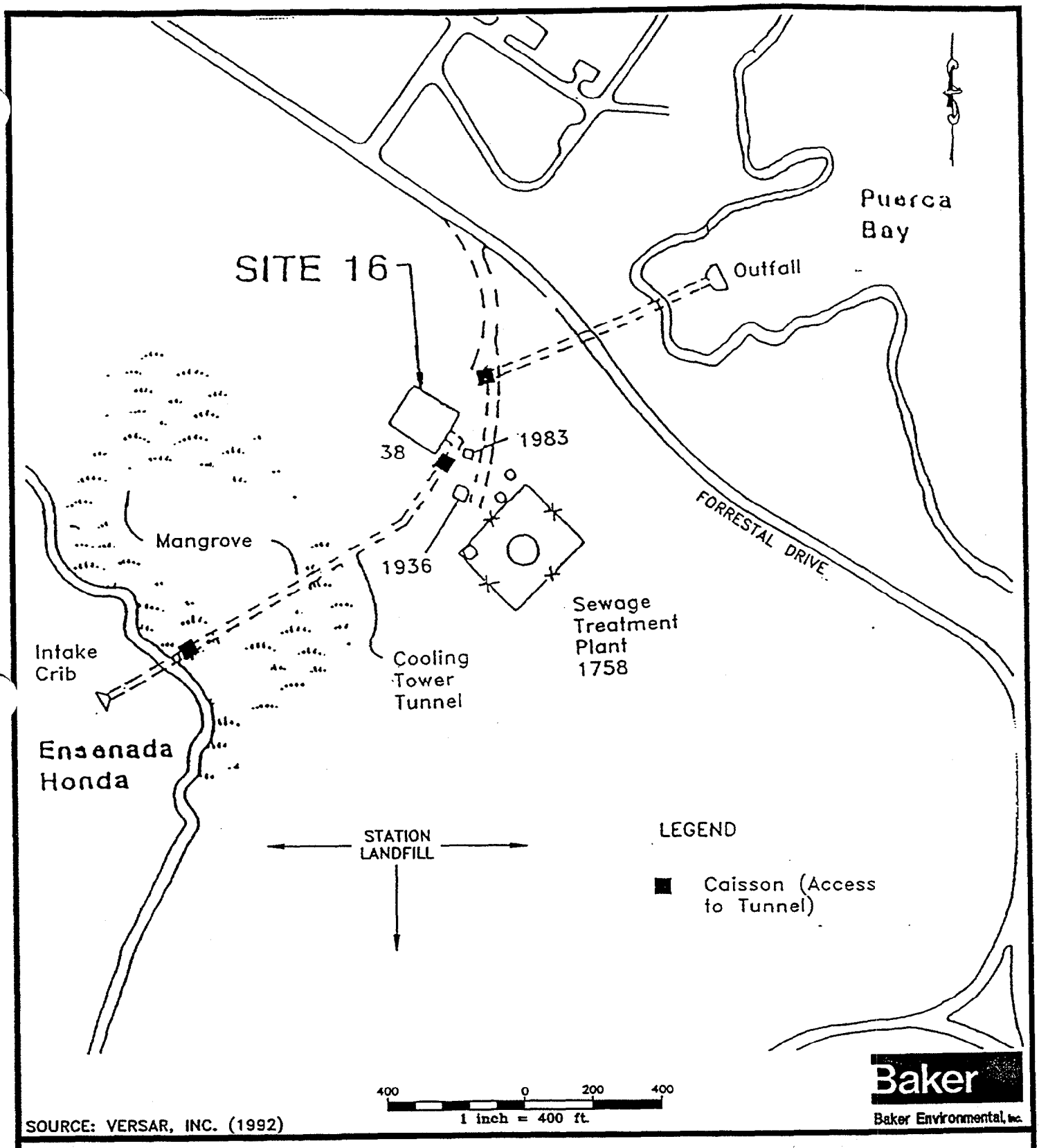


FIGURE 1-13
BASE MAP
SITE 16
OLD POWER PLANT, BUILDING 38

NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

00702130

WA

18GW1

64

HARDSTAND

FORRESTAL DRIVE

18GW3

258

18GW2

MARSH

WA WATERLINE?

100 0 50 100 200

1 inch = 100 ft.

DRAWING SCALE IS APPROXIMATE

LEGEND

18GW1 MONITORING WELL LOCATION

64 STATION STRUCTURE

SOURCE: STATION PUBLIC WORKS BASE MAP, FEB. 92

Baker

Baker Environmental, Inc.

FIGURE 1-14
BASE MAP
SITE 18, BUILDING 128
PEST CONTROL SHOP AND
SURROUNDING AREA
NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

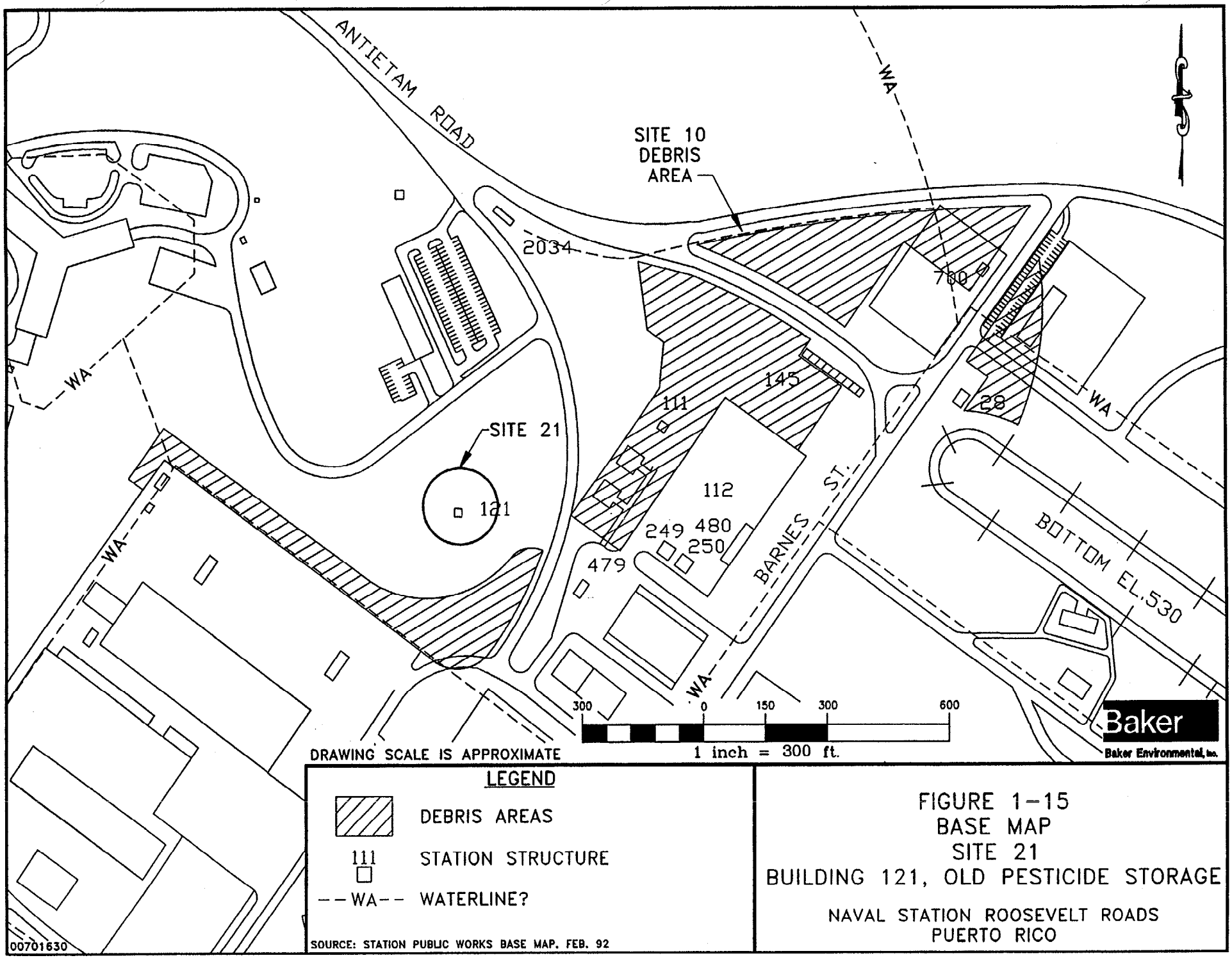


FIGURE 1-15
BASE MAP
SITE 21
BUILDING 121, OLD PESTICIDE STORAGE

NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

1.1.3 Technical Approach to Site Categories

Given the variation in intentions for the subject sites and the variations in characteristics, differing analytical matrices and sequences were selected for individual sites. The matrices and sequences of an individual site reflect the expected disposition of that site.

1.1.3.1 RFI Design - Sites 1, 2, 5, 6, 10, 14 and 18

With expectation of designing an RFI for each of Sites 1, 2, 5, 6, 10, 14 and 18, the relevant matrices were sampled at a particular site; Section 5.2.3 of the Work Plan indicates the reasoning in constructing this scheme. The characteristics of each site determined the available matrices for this Supplemental Investigation: Site 1 - soil and terrestrial sediments; Site 2 - disposal material, soil and marine sediments; Site 5 - groundwater and soil; Site 6 - groundwater and soil; Site 10 - soil; Site 14 - marine sediments; and, Site 18 - groundwater, soil, surface water and terrestrial sediments.

The analytical sequences for each matrix, regardless of site, included: VOC - volatile organic compounds of the Target Compound List (TCL); SVOC - semivolatile organic compounds of the TCL; P/PCB - pesticide and polychlorinated biphenyl compounds of the TCL; TAL - metals and cyanide of the Target Analyte List. Quality control of analyses was specified at NEESA Level D, equivalent to CLP procedures at EPA Level 4.

1.1.3.2 Relief From RFI Design - Site 13

Site 13 comprises three separated areas of fueling facilities with underground storage tanks (UST); no other operations are associated with these areas. Absent other indications of practices or disposal properly under RCRA provisions, these areas would fall under the UST regulations and be relieved of an RFI.

There had been some unconfirmed suggestion that disposal of lead sludge from tank cleanout had occurred. There was no mapping and there is presently no visible indication of the locations of disposal pits. Previous investigations (including the Site Visit, reported on 12 March 1992, made for this project) did not reveal strong evidence that the sites should be controlled separately from a UST program. An analysis of historical aerial photographs as part of the planning for the Supplemental Investigation indicated that no reasonable expectation could be held that disposal pits had been used.

Therefore, the technical conclusion on the disposition of Site 13 was made prior to the field program to recommend that Site 13 be regulated as a UST program. No further technical analysis of the conditions at Site 13 was made by the Supplemental Investigation.

1.1.3.3 Non-RFI Information - Sites 7, 16 and 21

For various reasons, information was obtained for Sites 7, 16 and 21 that would not be used directly in the Supplemental Investigation. Accordingly, these sites are not discussed in detail, although a report of activities and of groundwater elevations is included.

Site 7 is currently an operating landfill subject to RCRA monitoring. The NSRR is conducting this monitoring by means other than this Supplemental Investigation; however, information was obtained during this Supplemental Investigation to augment the information used under the RCRA monitoring for Site 7. This information was turned over to NSRR for use under this other program. The technical studies of Site 7 included: Analysis of aerial photography, measurement of groundwater elevations, collection of well-head test data, and sampling and analysis (VOC, SVOC, P/PCB and TAL) of groundwater.

Site 16 is currently under another IRP project. The information developed from the analyses of sediment and surface water for P/PCB and SVOC has been released to that project.

Site 21 is currently pending a RCRA Closure Permit. The information on analyses of selected waste constituents from soil and structural chips has been turned over to the office requesting that permit.

1.2 Background

1.2.1 General

NSRR occupies part of the northern side of the east coast of Puerto Rico, along Vieques Passage with Vieques Island lying to the east about 10 miles off the harbor entrance (Figure 1-1) from the CRP 72-2. The north entrance to NSRR is about 35 miles east along the coast road (Route 3) from San Juan. The closest large town is Fajardo (population, about 37,000), about 10 miles north of NSRR off Route 3. The closest town is Ceiba (population, about 17,000), adjoining the west boundary of NSRR.

The NSRR occupies over 33,500 acres, with some of the holdings being prepared for release to the Commonwealth of Puerto Rico. The NSRR has administrative and command responsibilities for some operations in Puerto Rico separated from the main base and Vieques Island (Figure 1-2).

The primary mission of NSRR is provision of full support for Atlantic Fleet weapons training and development activities.

The site of NSRR was first considered for location of a Naval Base in 1919, with no major facilities then available in the area. No development of the area was undertaken until early in the United States involvement in World War II, with the Naval Operating Base being commissioned in 1943 and finally redesignated a naval station in 1957.

More detailed descriptions can be found in Section 4.1.1 and 4.1.2 of the IAS (Section 1.3, below).

The project control documents for the Supplemental Investigation were published on 15 December 1992, following agreement with LANTDIV prior to the initiation of the field program on 29 October 1992. These documents (Section 7) comprise the Work Plan; the Sampling and Analysis Plan, containing the Field Sampling Plan and the Quality Assurance Project Plan; and the Health and Safety Plan.

The field program for the Supplemental Investigation formed Task 4 of the Work Plan. This report falls in Task 7, with the analysis of samples and evaluation of data appearing under Tasks 5 and 6.

1.2.2 Installation Restoration Program - Naval Station, Roosevelt Roads

IRP activities at NSRR have presented an Initial Assessment Study (IAS), dated September 1984, and a Confirmation Study (CS), completed in April 1988. These studies are being continued for selected sites during the conversion from CERCLA/Superfund status to RCRA status at NSRR. This Supplemental Investigation is not a standard CERCLA/RCRA/IRP program, but is related to the foundation of data for the RCRA Facilities Investigation (RFI) anticipated for the selected sites.

1.2.3 Description of Sites

Sites 1 and 2 are located on Vieques Island (Figures 1-2 and 1-3); the remainder are on the main base (Figures 1-1 and 1-6). The Environmental Protection Agency, Region II (EPA-II) has indicated that the sites on Vieques will be administered separately from those of the main base. The following sections summarize the descriptions of the sites from the available reports.

1.2.3.1 Site 1 - Quebrada Disposal Site, Vieques Island

Site 1 - Quebrada Disposal Site, Vieques Island lies along the east side of a steep ravine rising to the south from the coast road on the west side of the north of the island (Figure 1-4). The flatter parts of the ravine appear not to have been used for disposal, with most of the material being found on the steep slope. The disposal area extends roughly 950 feet from the road.

The area is densely overgrown with ground-cover surrounding the remaining, standing trees (Section 3.4.2). A large portion of the earlier growth of trees was blown down by a hurricane after disposal had ceased; these are now concealed within the ground-cover. When the site was active, the tree stand was intact and prevented the dense growth of ground-cover, while allowing ready access across the area. Access is now severely restricted by the ground-cover.

The site was used from the early 1960s to the late 1970s, with an area of about 500 by 20 feet and a depth of about 4 feet. The disposal volume has been estimated at about 1,500 cubic yards. The disposed materials at this site included general base refuse and industrial waste, with dispersal of the materials down this surface of the steep (60°) slope. The expected environmental concerns include (intermittent) surface water (as a transport mechanism rather than as an established environment), soil and sediment. Human receptors are currently expected to be affected through consumption of fish caught near the discharge from this site, as well as through potential exposure to contaminated soil during recreational fishing. Endangered species such as the Caribbean manatee and the hawksbill, leatherback, green and loggerhead sea turtles may also be affected by contamination at this site.

1.2.3.2 Site 2 - Mangrove Disposal Site, Vieques Island

Site 2 - Mangrove Disposal Site, Vieques Island lies along the coast road on the west part of the north side of the island (Figure 1-5). The main disposal area lies north of the road and east of

the lagoon channel crossed by the bridge on the coast road. The area is flat, and lies close to the level of the lagoons north and south of the road. Vegetation is fairly open, with a few trees of small to moderate size surrounded by mangrove and grass. The site is apparently subject to frequent flooding during storms.

This site was used during the 1960s and 1970s. The disposed materials at this site were general base refuse and industrial waste, estimated at about 800 cubic yards; some burning of this material apparently occurred. The expected environmental concerns include surface water (as an established environment), soil and sediment. Human receptors are currently expected to be affected through consumption of fish caught at this site, as well as through potential exposure to contaminated soil during recreational fishing. Endangered species such as the Caribbean manatee and the hawksbill, leatherback, green and loggerhead sea turtles may also be affected by contamination at this site. A large number of land crabs were observed during the Preliminary Site Visit. A layer of tar or asphaltic oil was also found beneath a veneer of mud during the Preliminary Site Visit; this layer appeared to have had no discernible, adverse effect on the local environment.

1.2.3.3 Site 5 - Army Cremator Disposal Area

Site 5 - Army Cremator Disposal Area lies on and around a knoll of elevated rock outcrop between the mangrove swamp on the west side of the harbor and the Navy Exchange area of the main base (Figure 1-7). The knoll has a thin development of soil and is now overgrown with moderately large trees and dense ground-cover. During disposal operations, this cover had been stripped, allowing access across the knoll. Presently, access is virtually impossible for useful purposes without extensive land-clearing (Section 3.4.2).

This site was used from the early 1950s to the early 1960s. The disposed materials at this site were general base refuse, municipal and industrial waste, and animal carcasses, estimated to total about 100,000 tons; some burning of this material apparently occurred. The expected environmental concerns include surface water (as an established environment), groundwater, soil and sediment. Human receptors are currently expected to be affected through consumption of fish caught at this site, as well as through potential exposure to contaminated soil during recreational fishing. The ecology of the Mangrove Swamp also may be affected by contamination at this site. No endangered species have been identified at this site.

1.2.3.4 Site 6 - Langley Drive Disposal Area

Site 6 - Langley Drive Disposal Area lies north of Site 5 in the margin of the mangrove swamp (Figure 1-8). The site is flat-lying and very near the level of the harbor, probably flooding frequently during storms and wind-driven tides. During disposal operations, the area had been cleared. Presently, however, there is a dense overgrowth of trees and shrubs of small to moderate size, with a dense network of vines; access is virtually impossible for useful purposes without extensive land-clearing (Section 3.4.2).

This site was used from 1939 to 1959. The disposed materials at this site were general base refuse and industrial waste, estimated at about 1,700 cubic yards. The expected environmental concerns include surface water (as an established environment), groundwater, soil and sediment. Human receptors are currently expected to be affected through consumption of fish caught offshore of this site, as well as through potential exposure to contaminated soil during recreational fishing. Endangered species such as manatees and sea turtles also may be affected by contamination at this site.

1.2.3.5 Site 7 - Station Landfill

Site 7 - Station Landfill lies on the peninsula (Figure 1-9) east of the harbor. The area is largely level and cleared, except for low brush across the inactive parts and for large trees with dense undergrowth on the harbor shoreline on the west side of the operating area. The landfill in slightly elevated above the harbor, and includes the spine of the peninsula (with the land surface apparently falling away to the west, south and east).

Since the 1960s, this site has been used as the Station landfill. The site encompasses about 85 acres. The disposed materials at this site were general base refuse, and industrial and hazardous waste; currently only general base refuse is disposed at this landfill. The expected environmental concerns include surface water (as an established environment), groundwater, soil and sediment. Human receptors are currently expected to be affected through recreational swimming and consumption of fish caught offshore at this site, as well as through potential exposure to contaminated soil during recreational fishing. Endangered species such as the West Indian manatee and several species of sea turtles may also be affected by contamination at this site. Potential exposure to fugitive dust from this site may also occur.

1.2.3.6 Site 10 - Building 25 Storage Area

Site 10 - Building 25 Storage Area is within the main area for base support activities. Building 25 was destroyed during a hurricane, with the debris scattered over the area indicated on Figure 1-10. The area is presently occupied by various industrial activities, including storage, heavy maintenance and construction of a new building south of the foundation of Building 25.

Building 25 was used for temporary storage of material from the 1940s to 1979, when it collapsed. The site contains material from the collapsed building, around the building and in the immediate vicinity. The potential environmental concern is related to the scattering of debris during and after the collapse. This debris would now be considered dominantly an industrial waste. There are no intact structures at this site which pose an environmental concern. There are some building construction activities currently underway at this site.

The expected environmental concerns include groundwater and soil. Human receptors are currently expected to be affected through dermal contact with soil and inhalation of particulates. Local wildlife may also be affected by soil contamination.

1.2.3.7 Site 13 - Tanks 210-217

Site 13 - Tanks 210-217 includes three underground fueling facilities (Figure 1-11) on the perimeter of the mangrove swamp on the east side of NSRR. Each (tank farm) facility lies in a clearing on a shallow hillside with no other operations adjacent.

The tanks were constructed of concrete in 1944 for the storage of AVGAS (aviation gasoline) and were cleaned every five years. The following list indicates what is known regarding the various tanks:

- Tank 210 - 50,000 gallons AVGAS
- Tank 211 - 50,000 gallons AVGAS
- Tank 212 - 50,000 gallons formerly AVGAS, currently unleaded gasoline
- Tank 213 - 50,000 gallons formerly AVGAS, currently unleaded gasoline
- Tank 214 - 248,000 gallons
- Tank 215 - 245,000 gallons

- Tank 216 - 245,000 gallons formerly AVGAS, currently unleaded gasoline
- Tank 217 - 247,000 gallons formerly DFM (diesel fuel, marine), currently JP-5 (turbine fuel, Type 5)

According to the IAS, Tanks 210 and 211 were abandoned in 1950 and had probably been cleaned only once. Tank cleaning normally resulted in removal of 800 to 1,250 gallons of leaded sludge per tank, disposed in pits adjacent to each tank. An estimated 30,000 to 50,000 gallons of leaded sludge could have been disposed over a 40-year period in pits. These suspected sludge disposal pits are the subjects of the current investigation; however, no evidence of their existence was found. The tank farm has active and inactive storage and dispensing facilities for fuels.

The expected environmental concerns include surface water (as an established environment), groundwater, soil and sediment. Human receptors are currently expected to be affected through consumption of fish caught in the harbor, as well as through potential exposure to contaminated soil. Potential inhalation exposure to vapors generated from the tanks also may occur. The ecology of the mangrove swamp may also be affected by contamination at this site.

1.2.3.8 Site 14 - Ensenada Honda Shoreline and Mangroves

Site 14 - Ensenada Honda Shoreline and Mangroves lies on the west side of the harbor, north and south of the Coast Guard facility (Figure 1-12). The tidal margin of the mangrove swamp extends several scores of feet from the open water of the west harbor to the firmer ground of the west shore. Within this margin, there is little solid ground; all of the area is flooded during storms and most of it is flooded by semidiurnal tides. Site 14 forms the east side of Sites 5 and 6. There is no base operation except access to the Coast Guard Station occupying this area.

The shoreline at this site had been subjected to a major, open-water spill of about 210,000 gallons of marine diesel fuel in 1981. The sediment and surface water matrices would be the principal indicators of potentially adverse environmental effects. The location of the site at the tidal margin indicates that groundwater should not be a concern; the potential of the site as a potable groundwater resource is eliminated by the influence of the marine surface waters. Human receptors are currently expected to be affected through consumption of fish caught at this site, as well as potential exposure to contaminated sediment during recreational fishing. Ecological receptors include the manatee and sea turtle, as well as the endangered yellow-shouldered blackbird.

1.2.3.9 Site 16 - Old Power Plant, Building 38

Site 16 - Old Power Plant, Building 38 lies north of Site 7 (Figure 1-13). The plant was in operation for only a decade, but had since been used for casual maintenance activities and for storage. An intake tunnel leads east from the building to Puerca Bay, while a similar outfall leads west to the harbor.

The Old Power Plant, Building 38 was used as a 60 megawatt steam-turbine facility that generated power from the early 1940s through 1949. From 1956 to 1964, transformer maintenance was performed at Building 38 by the Public Works Power Distribution Shop (Versar, 1992).

Versar, Inc., completed a Remedial Investigation/Feasibility Study (RI/FS) for this site in 1992. The results of the RI determined that concrete surfaces, and sediment and soil surrounding the immediate area are contaminated with PCBs at concentrations exceeding ARARs. Surface water and wipe samples collected from the cooling water tunnel and UST manways indicate that these areas are also contaminated with PCBs.

Human receptors could be affected through consumption of fish caught at this site, as well as potential exposure to contaminated sediments during recreational fishing or swimming. The endangered species in this area also may be affected by contamination at this site.

1.2.3.10 Site 18 - Building 128, Pest Control Shop and Surrounding Area

Site 18 - Building 128, Pest Control Shop and Surrounding Area is adjacent to a heavily trafficked road (Forrestal Drive) north of the main area for base support activities. Building 128 has been dismantled, with the foundation and hardstand remaining (Figure 1-14) west of Forrestal Drive. A drainage ditch parallels the west side of the road; a heavily overgrown area borders the reverse side of the site.

Building 128 served as the Pest Control Shop from the late 1950s to 1983. Spillage of pesticides occurred in and around the building during this time. Pesticide application equipment was cleaned over a storm-drain discharging into a ditch behind the building. Excess pesticides were also discarded in this ditch. Currently, the building is no longer standing; with removal following excessive damage from a hurricane. The expected

environmental concerns include surface water (as an established environment), groundwater, soil and sediment. Human receptors are currently expected to be affected through consumption of fish caught at the site, as well as through potential exposure to contaminated soil. Exposure to fugitive dust may also occur. The endangered species in this area also may be affected by contamination at this site.

1.2.3.11 Site 21 - Building 121, Old Pesticide Storage

Site 21 - Building 121, Old Pesticide Storage (Figure 1-15) sits on a hillside above Site 10 and below the Station Hospital. The abandoned building is surrounded by a moderately dense growth of trees, with an access road cut to a main road leading off Antietam Road to the Public Works Building.

This site had not been identified in the IAS, but had been listed in the RFA (RCRA Facilities Assessment). This building was used from 1980 to 1988 for the storage of outdated pesticides. Building 121, Old Pesticide Storage, is suspected of material handling losses of pesticides. The expected environmental concerns at this site include soil and the building itself. Human receptors are currently expected to be affected by contact with contaminated soil, as well as possible contact with the building interior. Fugitive dust from contaminated soil may also be a potential exposure pathway. The ecology in the area is also expected to be affected.

1.3 Summary of Previous Investigations

As part of a Navy-wide program to manage past disposal sites through the Naval Assessment and Control of Installation Pollutants (NACIP) initiated in September 1980, NSRR was designated for an Initial Assessment Study (IAS) of its environment in March 1982 by the Naval Energy and Environmental Support Activity (NEESA), Port Hueneme, California.

The IAS was conducted in 1983 and 1984 by Greenleaf/Telesca Planners, Engineers, Architects (Miami, Florida) and by Ecology and Environment (Buffalo, New York). The IAS consisted of a records search at various government agencies, national and regional archives, and USGS; an on-site survey; and personnel interviews. The study identified sixteen sites that warranted further study under the NACIP Program.

In May 1986, the CS was performed by Environmental Science and Engineering (ESE) of Gainesville, Florida. Fifteen of the sixteen potentially contaminated sites identified in the

IAS were investigated as part of this study; the last site had been cleaned up prior to this study. Two rounds of samples were collected from these sites by ESE. The Confirmation Study Report was completed by April 1988 and indicated that 14 sites required additional effort under the NACIP program.

In October 1990, a Scope of Work (SOW) for Installation Restoration (IR) Program Efforts at NSRR was released. This SOW was designed to direct investigative and remedial efforts at Sites 3, 8, 9, 15 and 16.

In June 1991, a second SOW and Work Plan under the IR program was released to guide the sampling and remedial efforts at Sites 1, 2, 5, 6, 7, 10, 13, 14 and 18, and to conduct a Site Investigation (SI) at a previously unidentified site (Site 21 - Building 121, Old Pesticide Storage).

1.4 Report Organization

The report of the Supplemental Investigation provides:

- Section 1.0 - Introduction

  This section contains background information relevant to the prosecution of the Supplemental Investigation and to the IRP process at NSRR and the relevant findings of previous investigations. The objectives of the Supplemental Investigation are stated in Section 1.1.

- Section 2.0 - General Description

  This section presents information on the regional setting of NSRR, regarding geography (topography, soils, climate and hydrology), geology and geohydrology, and ecology.

- Section 3.0 - Field Activities - Supplemental Investigation

  The general procedures and expectable results of the technical methods of the field program are presented, both for the principal mechanisms of the investigation and for the support practices most essential to the investigation.

- Section 4.0 - Technical Analysis - Geologic Conditions

  Detailed presentations of data and discussions of analyses provide the results of the field program implemented for the Supplemental Investigation. The data and analyses are presented separately for each site according to the type of technical study. The significant results of the chemical analyses are presented, although detailed discussion is differed until Section 5.0.

- Section 5.0 - Evaluation of Potential Human Health Risk and Ecological Effects

  This section presents detailed calculation of the effects of the chemical compounds found on human health and the environment. The results of the chemical analyses are presented in detail, with an objective evaluation of their cumulative effect on the status of the site.

- Section 6.0 - Conclusions and Recommendations

  The significant data, analyses and findings for each site are detailed.

- Section 7.0 - References and Bibliography

  Reports and relevant sources in the available literature are cited.

2.0 GENERAL DESCRIPTION

The physical setting of NSRR was documented in the 1984 IAS (NEESA Document 13-051). This information is summarized below.

2.1 Physical Geography

2.1.1 Topography and Soils

2.1.1.1 Topography

The region of Roosevelt Roads consists of an interrupted, narrow Coastal Plain with small valleys extending from the Sierra de Luquillo range, which has been severely eroded by streams into valleys several hundreds of feet deep. Slopes of up to 60° are common.

In the immediate area of NSRR, elevations range from sea level to approximately 295 feet. Immediately to the north of the NSRR boundary, the hills rise abruptly to heights of 800 to 1,050 feet above sea level, with the tallest peak located within two kilometers of the NSRR boundary. There is a series of three hilly areas on NSRR, two of which separate the southern airfield area from the Port/Industrial, Housing and Personnel Support areas. The third set of hills is in the Bundy area. These ridge lines not only separate sections of NSRR, but dictate the degree of allowable development. The ridge line south of the airfield provides an excellent barrier which effectively decreases the aircraft-generated noise which reaches the Unaccompanied Enlisted Personnel Housing areas to an acceptable level. Relief is low along the shoreline. Lagoons and mangrove swamps are common.

2.1.1.2 Soils

The soil associations found at NSRR are dominantly of two types typical of humid areas, namely the Swamps-Marshes Association and the Mabi-Rio-Arriba-Cayagua Association, as well as the Descalabrado-Guayama Association, which is typical of dry areas. In addition, isolated areas of the Caguabo-Mucara-Naranjito Association, the Coloso-Toa-Bajura Association, and the Jacana-Amelia-Fraternidad Association are found at NSRR.

The Swamps-Marshes and Mabi-Rio-Arriba-Cayagua associations cover over one half of NSRR's surface area and are equally distributed. The remaining area is covered primarily by the Descalabrado-Guayama and Caguabo-Mucara-Naranjito associations.

The Swamps-Marshes Association consists of deep, very poorly drained soils. This association is found in level or nearly level areas that are slightly above sea level but are wet, and when the tide is high, are covered or affected by saltwater or brackish water. The soils are sandy or clayey, and contain organic materials from decaying mangrove trees. They are underlain by coral, shells and marl at varying depths. The high concentration of salt inhibits the growth of all vegetation except mangrove trees, and in small scattered patches, other salt-tolerant plants.

The Mabi-Rio-Arriba-Cayagua Association consists generally of deep, somewhat poorly drained and moderately well-drained, nearly level to moderately steep soils found on foot and side slopes, terraces and alluvial fans. Soils of this association at NSRR are basically clayey, and are located dominantly in the areas surrounding Ofstie Field.

The Descalabrado-Guayama Association generally consists of shallow, well-drained, strongly sloping to very steep soils on volcanic uplands. Soils of this association are found primarily in the hilly areas located directly inland and adjacent to the soils of the Swamps-Marshes Association.

The Caguabo-Mucara-Naranjito Association consists generally of shallow and moderately deep, well-drained, sloping to very steep soils on volcanic uplands. This association consists of soils which formed in residual material that weathered from volcanic rocks. This association is represented at NSRR by soils of the Sabana series, which are found on the side slopes and the hilly terrain west of Langley Drive in the Fort Bundy area. These soils are suited for pasture and woodland. Steep slopes, susceptibility to erosion and depth to bedrock are the main limitations for farming, and for recreation and urban areas.

The Coloso-Toa-Bajura Association consists of deep, moderately well drained to poorly drained, nearly level soils found on floodplains. This soil association extends along the western boundary of NSRR and around the airfield. The soils of this association formed in fine-textured and moderately fine-textured sediment of mixed origin on floodplains. The Coloso soils are deep and somewhat poorly drained; the Toa soils are deep and moderately well drained; and the Bajura soils and Maunabo soils are deep and poorly drained. The Reilly soils,

also part of this association, are shallow sand and gravel and are excessively drained; they lie adjacent to streams. The minor soils are Talante, Vivi, Fortuna, Vega Alta and Vega Baja. The Talante, Vivi, Fortuna and Vega Baja soils are found on floodplains, while the Vega Alta soils occupy slightly higher positions on terraces.

The Jacana-Amelia-Fraternidad Association consists generally of moderately deep and deep, well-drained and moderately well-drained, nearly level to strongly sloping soils on terraces, alluvial fans and foot slopes. This association is represented at NSRR by soils of the Jacana series, which consist of moderately deep, well-drained soils found on the foot slopes and low rolling hills along Langley Drive and just east of the airfield. These soils formed in fine-textured sediment and residuum derived from basic volcanic rocks.

2.1.2 Climate

The climate of the Roosevelt Roads area is warm and humid, with frequent showers occurring throughout the year. A major factor affecting the weather is the pattern of trade winds associated with the Bermuda High, the center of which is in the vicinity of 30° North, 30° West.

The prevailing wind direction reflects the easterly trade winds. The area receives a surface flow varying between the northeast to the southeast about 75 percent of the year, and as much as 95 percent of the time in July when the easterly winds are strongest. The differential heating of the land and sea during the day tends to give a more northerly component to the flow on the northern side of the island and a more southerly component on the southern side. During the night, a land breeze causes a prevailing southeasterly flow in the north and a prevailing northeasterly flow over the southern coast. The mean annual wind velocity is 5.5 knots, with a minimum in November and a maximum in August. Gales associated with westward moving disturbances in the trade winds or hurricanes passing either north or south of the area have the highest probability of occurrence from June through October.

Uniform temperatures prevail, with small diurnal ranges as a result of insular exposure and the relatively small land areas. The warmest months are August and September, while the coolest are January and February. Mean annual maximum temperatures range from 82.0° in January to 88.2°F in August. The mean annual minimum temperatures vary from 64.0° in January to 73.2° in June. The highest maximum temperature recorded was 95°F, while the lowest minimum was 59°F.

Rain usually occurs at least nine days in every month, with an average of 60 inches per year. A dry winter season occurs from December through April. About 22 thunderstorm-days occur per year, with maximum frequencies of three days per month from May through October.

In late summer, the mean sky-cover begins a steady decrease from a monthly maximum average of 6.5-tenths coverage in September to a minimum monthly average of 4.4-tenths coverage in February. From March through August, the monthly average clouds-over increases steadily from 4.5- to 6.0-tenths coverage. Over the open sea, a maximum of clouds (usually broken stratocumulus) occurs during early morning, with the skies clearing or becoming scattered with cumulus by afternoon. Completely clear or overcast skies are rare during daylight hours, while clear skies frequently occur at night.

The hurricane season is from mid-June through mid-September; maximum winds exceed 95 knots during severe hurricanes. An average of two tropical storms per year occur in the study area, one of which usually reaches hurricane intensity.

2.1.3 Hydrology

The surface waters that flow across the northeastern plain of Puerto Rico, where NSRR is located, originate on the eastern slopes of the Sierra de Luquillo mountains. Surface runoff is channeled into various rivers and streams which eventually flow into the Caribbean Sea. The Daguao River and Quebrada Seca Stream (a tributary to Rio Daguao) collect surface waters from the hills immediately north of NSRR, and in periods of heavy rain, on-station flooding occurs. The Daguao-Quebrada Seca watershed comprises an area of approximately 7.6 square miles (4,900 acres), and the river falls some 700 feet from its source to sea level. Increased development in the Town of Ceiba, especially in areas adjacent to the NSRR's northern boundary, has significantly increased the surface runoff reaching NSRR, causing ponding and erosion in the Boxer Drive area. Boxer Drive, for a major portion of its length, is subject to surface water flooding, as are Hangar 200 and AIMD Hangar 379 and adjacent apron areas.

In the low-lying shore areas, seawater flooding results from storms, wind and abnormally high tides. The tidal ranges in the Roosevelt Roads area are rather small, with a maximum spring range of less than three feet. The tides are semidiurnal and have a usual range of about one foot in the main harbor of NSRR.

Little information exists concerning the geohydrology of NSRR. The only known potential sources of groundwater lie in lenticular beds of clay, sand and gravel, and rock fragments which occur at a depth of less than 30 meters. No wells have been developed on-base from these layers. Some wells had been developed upgradient of NSRR in Ceiba, some three kilometers from base headquarters, but were abandoned due to high levels of salinity.

The quality of surface waters is variable, reflecting the drainage area through which the water flows. Generally, surface waters have high turbidities and bio-organics (naturally-occurring organics, such as decay products of vegetable and animal matter) due to the periodic heavy rains which can easily erode soils from steep slopes, exposed areas and disturbed stream beds.

Water from alluvial aquifers along the coast of NSRR is of a calcium bicarbonate type, and has high concentrations of iron and manganese. The source of these minerals is unknown, but they may be derived from buried swamp or lagoon deposits.

A seawater-freshwater interface is present in the aquifers throughout the coastal areas of Puerto Rico, usually within a short distance inland of the coastline.

The NSRR water treatment plant receives its raw water from the Rio Blanco through a 27-inch reinforced concrete pipe that replaced the old, open channel. The intake is located at the foot of the EI Yunque rain forest. This buried raw water line traverses a distance of 14 miles from the intake to the NSRR boundary. A raw water reservoir is located at the water treatment plant and has a 45-million gallon capacity. Additionally, there are two fire protection storage reservoirs with a total capacity of 520,000 gallons.

The base has been served for over 30 years by the present treatment facility. The plant (Building 88) has a capacity of 4.0 million gallons per day (mgd). Water flows by gravity into a 45 million gallon raw water storage basin from which the plant draws its supply at a rate of 1.3 mgd on average. Treatment consists of prechlorination, coagulation sedimentation, filtration and post-chlorination.

The single potable water supply system provides water to all industrial operations at the facility. The water supply is low in hardness, and, therefore, is an excellent source for industrial uses, particularly in boiler operation and maintenance.

Three hundred acres are used for pasture near Gate 1, and are irrigated as needed. Extensive sprinkling of lawns and green areas is evident throughout the base.

Surface runoff would occur throughout the series of drainage ditches, which empty either into the Rio Daguao watershed and from there into Vieques Passage, or into the mangroves that fringe Ensenada Honda and Puerca Bay.

2.2 Regional Geology and Geohydrology

The geology of the NSRR area is dominantly volcanic (composed of lava and tuff), as well as sedimentary (rocks derived from discontinuous beds of limestone). These rocks all range in age from early Cretaceous to middle Eocene. The volcanic rocks and interbedded limestones have been complexly faulted, folded, metamorphosed and variously intruded by dioritic rocks. This complex geological structuring occurred sometime after the deposition of the limestone during the middle Tertiary, when Puerto Rico was separated from the other major Antillean Islands by block faulting, and was arched, uplifted and tilted to the northeast. Culebra, Vieques and the Virgin Islands are part of the Puerto Rican block; they are separated from the main island simply because of the drowning that resulted from the tilting.

In addition to the dominant volcanic and sedimentary rock, the northwestern and western sectors of the base are underlain by unconsolidated alluvial and older deposits from the Quaternary period.

The primary geologic formations on and near NSRR are various beach deposits, alluvium, quartz diorite and granodiorite, quartz keratophyre, the Daguao Formation, and the Figuera Lava. The NSRR is traversed by the Peña Pobre fault zone.

Groundwater at Roosevelt Roads flows generally southeast, except in the areas of high ground on the peninsulas which constitute the Industrial Area where Sites 7, 10 and 13 are located. In these areas, due to the steep slopes (as much as 40 percent), relatively shallow well-drained soils, and proximity of bedrock to the surface, subsurface groundwater migration will be in the downslope direction dictated by local topography. This will generally be to the north and northeast into the mangrove swamps and Puerca Bay, or to the south and southeast into Ensenada Honda.

2.3 Regional Ecology

Section 4 of the IAS provides a detailed discussion of the ecology of NSRR and NAF-V. As indicated in Sections 5 and 6 of this present report, no further discussion is warranted for the purposes of the Supplemental Investigation.

3.0 FIELD ACTIVITIES - SUPPLEMENTAL INVESTIGATION

3.1 Technical Activities of the Field Program

The studies for the Supplemental Investigation fell into the following major categories: photo-interpretation and map analysis; geophysical investigation; well-head tests; representation of groundwater flow; and sampling and analysis.

3.1.1 Photo-Interpretation and Map Analysis

A detailed interpretation of historical aerial photographs was undertaken for each of the sites addressed by the Supplemental Investigation, regardless of its status in the RFI preparation. This interpretation was made by a private contractor in a fashion similar to the EPIC (Environmental Photo-Interpretation Center) analyses of the EPA for CERCLA/RCRA sites. The detailed GeoDecisions, Inc. report is included as Appendix 3.A.

The interpretation extended to the historical limit of coverage, attempting an analysis for each site of relevant physical features, disposal locations and practices, and changes through time. Detailed descriptions of these concerns were available during the planning for the field program and in the early part of the field program. This information was very useful in developing the rationale for investigations, as well as presenting independent findings at the particular sites on extent of disposal and on disposal practices; these descriptions are notably absent from the existing reports on the sites.

The photo-interpretations were especially useful at Sites 1, 5 and 6, where there are no reliable indications in the previous reports on the locations of disposal at these sites. Field reconnaissance on the ground and by aircraft had similarly been unable to find the disposal areas.

Map analyses were made of each site in operational planning. These analyses were coordinated with the interpretation of aerial photographs, particularly at Sites 5 and 6, in preparing the description of the extent of disposal at particular sites.

The subsections which follow summarize the findings of the historical air photo analyses on a by-site basis.

Site 1 - Quebrada Disposal Site, Vieques Island

The only usable photograph available for analysis of Site 1 operations was taken March 18, 1967. From this photograph, the only apparent activity is frequent use of the access road.

Site 2 - Mangrove Disposal Site, Vieques Island

No usable photograph for analysis of Site 2 operations could be found.

Site 5 - Army Cremator Disposal Area

The usable photography of Site 5 operations is:

January 8, 1951: A trench with vehicles is noted on the southwest side of the knoll. Structures of undefined use appear between the trench and the top of the knoll. The northwest side of the knoll appears to have been top-stripped.

June 18, 1958: A deep trench with burning material and mounded fill appears on the west side of the knoll, farther from the top than the trench noted previously. The disturbance of the northern part of the site has expanded.

October 29, 1958: Containers appear near mounded fill on the southwest side of the knoll.

November 15, 1964: The first trench noted (January 8, 1951) is no longer visible; another trench, apparently for drainage, is evident farther south.

December 20, 1977: The entire site has been completely overgrown; no artificial features are distinguishable.

Site 6 - Langley Drive Disposal Area

The usable photography of Site 6 operations is:

January 8, 1951: The disposal area had been cleared and was active, with an access road leading to the face of the fill.

June 18, 1958: No change is noted.

October 29, 1958: No change is noted.

December 20, 1977: The entire site has been completely overgrown; no artificial features are distinguishable.

Site 7 - Station Landfill

The usable photography of Site 7 operations is:

January 8, 1951: The center of the site is a sand quarry. The only indication of possible disposal is an area of dark material in the northwest part of the site potentially related to release of a liquid.

June 18, 1958: The sand quarry had expanded to include the east side of the present landfill.

November 15, 1964: The entire site has been nearly completely overgrown. No artificial features are distinguishable other than three, small, clear areas and an undefined structure on the east side of the present landfill.

December 20, 1977: Disposal of materials is apparent in the center of the present landfill. Land-clearing has proceeded on the west side of the site.

Site 10 - Building 25 Storage Area

The usable photography of Site 7 operations is:

January 8, 1951: All buildings shown on the current USGS topographic map are apparent in this photograph. Areas of various open storage are visible.

June 18, 1958: The area of activity has expanded. One building has been removed and another added.

November 15, 1964: No change is noted.

December 20, 1977: Activity had increased.

Site 13 - Tanks 210-217

The usable photography of Site 13 operations is:

June 18, 1958: This photograph appears to show construction of the UST farms. No evidence of contaminant release is visible on this or subsequent photographs. Subsequent photography indicates extensive overgrowth of the area, with no other notable features.

Site 14 - Ensenada Honda Shoreline and Mangroves

There is no useful description of Site 14 available.

Site 16 - Old Power Plant, Building 38

Site 16 was not included in the project until after completion of the photo-interpretation. No useful description is available; however, none would be expected, considering the operational status of the site.

Site 18 - Building 128, Pest Control Shop and Surrounding Area

The usable photography of Site 18 operations is:

January 8, 1951: The site had been top-stripped, with sheds and a building (probably unrelated to Building 128) apparent in the southeast corner. A drainage channel exits the east part of the south boundary of the site.

June 18, 1958: The structures have been removed. Two new buildings (also probably unrelated to Building 128) appear. Various clearing and filling is visible.

November 15, 1964: Some revegetation has occurred on the margins of the site.

December 20, 1977: Only minor increases in revegetation have occurred.

Site 21 - Building 121, Old Pesticide Storage

The usable photography of Site 21 operations is:

January 8, 1951: Building 121 is visible. Another building, significantly larger than Building 121, is apparent directly east and downslope of Building 121 (no evidence of this structure remains).

June 18, 1958: The larger building has been removed; revegetation of this location continues through the present.

3.1.2 Geophysical Investigation

The geophysical surveys were conducted after land-clearing had exposed areas indicated by the photo-interpretation to have been part of the disposal operation at Site 5; no other sites were examined by geophysical methods. These surveys involved: (1) EMI mapping of contrasts in subsurface material that indicated artificial boundaries, such as trench walls, associated with disposal practices; and, (2) MAG mapping of subsurface metallic objects, usually associated with disposal. The report of the geophysical investigation is attached as Appendix 3.B. A summary of findings appears below.

The traverses followed the access lanes shown on Figure 4-3. Heavy equipment cleared the lanes along orientations selected following review of the photo-interpretation and map analysis, and according to examination of the exposed parts of the lanes as they were advanced.

Correlation between the disposal features noted by the photo-interpretation and the disposal indications found during land-clearing is very high. The indicated disposal features were found on the southwest side in the locations transferred from the aerial photographs to the maps. Similarly, areas indicated by photo-interpretation not to have been used for disposal appeared undisturbed except for top-stripping.

The geophysical interpretation agrees with both the photo-interpretation and the visual inspection of the ground. The geophysical interpretation, however, provides more precise mapping of the disposal feature along the respective traverse line. The geophysical survey also indicates the probable relative concentration of metallic objects in the disposal feature.

During the field program, the preliminary geophysical interpretation was correlated with the preliminary photo-interpretation to finalize siting of the sampling stations for soils at Site 5. The field evidence indicates a very high confidence that the data stations are properly sited in relation to the disposal features.

3.1.3 Physical Geohydrology

The wells at Site 1 were found dry during the field program. Of the wells at Site 5 indicated in the Work Plan for measurement, only 05GW01 could be found. Only 06GW01 exists at Site 6. All eight of the wells at Site 7 were accessible. The use of wells at Site 10 was not included in the program. All three of the wells at Site 18 were accessible.

3.1.3.1 Well-Head Tests

Examination of aquifer parameters for the Supplemental Investigation consisted only of slug-tests for calculation of the local hydraulic conductivity. This technique is well represented in environmental investigations as a general or reconnaissance characterization of the aquifer parameters across the area of a study site. Calculation of the hydraulic conductivity provides a basis for estimation of the rate of flow of groundwater, and on the probable rate of transport and area of distribution of contaminants entrained in the groundwater.

Tests were made for wells at Sites 5, 6, 7 and 18 (the wells at Site 1 were found dry; the tests intended in the Work Plan for Site 10 were deleted. Only one well identified in the Work Plan for Site 5 could be located in the field. Only one well is available at Site 6. The data for the wells at Site 7 is not included herein but has been provided to the program addressing that operation. The data from the three wells at Site 18 will be discussed below in representing the potential pattern of groundwater flow and contaminant migration around the site.

3.1.3.2 Groundwater Flow

Measurements of water levels were made for wells at Sites 5, 6, 7 and 18 (the wells at Site 1 were found dry). Only one well identified in the Work Plan for Site 5 could be located in the field. Only one well is available at Site 6. The data for the wells at Site 7 will be released to the program addressing that operation. The tests intended in the Work Plan for Site 10 were

deleted; these tests were of lesser importance than for the other sites, since chemical analyses were not made at Site 10. The data from the three wells at Site 18 will be discussed below in representing the configuration of the water table at that site.

Measurements of water levels in the monitor wells at Site 18 were calculated (vertically and horizontally) from the survey data to provide a representation of the shape of the water table underlying Site 18. This further indicates the direction of flow of groundwater and of the distribution of contaminants in the groundwater. The usual result of this analysis is a groundwater contour map, with calculation of gradient from the stream-lines represented on the map or from a three-point calculation. Derivation of this gradient contributes to the representation of the rate of groundwater movement and potential contaminant transport.

The groundwater measurements and calculated elevations appear on Table 3-1. Groundwater contour maps cannot be prepared for Sites 1, 5 and 6 due to insufficient distribution of data stations. A groundwater contour map cannot be prepared for Site 7 due to the radial nature of flow associated with the peninsula on which it is placed.

From the values on Table 3-1 for Site 7 on the initial sampling date of November 18, 1992, the wells on the sand ridge of the peninsula have the higher values of groundwater elevation: R7GW01 at 0.77 feet; R7GW08 at 0.66; R7GW06 at 0.81; R7GW05 at 0.72; and R7GW04 at 0.21. The wells nearer the low shoreline have the lower values: R7GW02 at -2.89; R7GW03 at -3.99; and R7GW07 at 0.00.

The relevant groundwater elevations for Site 18 are 18GW01 (3.71 feet); 18GW02 (3.78 feet); and, (18GW03 (5.43 feet), reflecting the data of the original sampling date November 11, 1992.

Groundwater at Site 18 flows generally to the west; a gradient cannot be calculated properly from the data on Table 3-1. The distribution of elevations shows little separation between the elevations of the water table at 18GW01 and at 18GW02; this slight separation is insufficient to the calculation of gradient and to the construction of groundwater contours. The distribution variations (Table 3-1) are relatively slight; however, they do not follow the topographic expression, which would have predicted the upslope station (18GW01) to have a higher elevation than the bottom-land stations (18GW02 and 18GW03).

The values cited are representative of the trends noted during the field investigation.

TABLE 3-1

GROUNDWATER ELEVATIONS
NAVAL STATION, ROOSEVELT ROADS, PUERTO RICO

Station	Measurement Point Elevation (feet MSL)	Ground Surface Elevation (feet MSL)	Groundwater Elevation (feet MSL)							
			11/10/92	11/11/92	11/18/92	11/19/92	11/21/92	11/24/92	11/26/92	12/1/92
05GW01	17.90	14.4	6.64	6.64		7.08	7.12			7.15
06GW01	14.36	14.0	6.21	6.21		5.54	5.55			
R7GW01	12.32	9.3	0.82		0.77				0.74	
R7GW02	0.72	-1.5	-2.89		-2.89				-2.96	
R7GW03	3.49	1.7	-3.85		-3.99			-3.80	-3.79	
R7GW04	12.39	10.0	0.71		0.21				0.57	
R7GW05	13.52	11.8	0.74		0.72	3.05				
R7GW06	14.19	11.7	0.60		0.81			0.64		
R7GW07	15.70	12.2	-0.07		0.00					
R7GW08	11.34	8.8	0.70		0.66					
18GW01	13.36	12.8	3.71	3.71	3.91	3.88	4.00	4.00		
18GW02	10.62	9.6	3.93	3.78	0.97		4.11			
18GW03	9.31	8.6	5.43	5.43	4.70		6.16	5.51		

3.1.3.3 Hydraulic Conductivity

The calculated values for hydraulic conductivity appear in Appendix 3.C and are summarized on Table 3-2.

From the values on Table 3-2 for Site 7, the wells on the east side of the sand ridge of the peninsula have the higher values of hydraulic conductivity: R7GW06 at 2.2 feet/day; R7GW07 at 3.3; and R7GW08 at 2.2. These are about double the values for the remaining wells, all of which (except R7GW01 at 0.23 feet/day) are off the spine of the peninsula and near the shorelines.

The values for 05GW01 and 06GW01 fall in the range (0.86 and 0.72 feet/day, respectively) of the shoreline wells at Site 7. This accords with the similar positioning of the Site 5 and 6 stations near the edges of the mangrove swamps.

From the values on Table 3-2 for Site 18, the well (18GW01) farthest upslope from the drainage at the south of the site, and probably more influenced by upland sands, has the highest calculated conductivity at 1.3 feet/day. The remaining two wells are lower on the slope of the site and probably more influenced by bottom-land silts (18GW02 at 0.15 feet/day, and 18GW03 at 0.14 feet/day).

3.1.3.4 Groundwater Transport - Site 18

Groundwater transport is usually calculated by the variation of Darcy's Law:

$$v = Ki/n$$

where: v = average velocity of groundwater
K = hydraulic conductivity
i = calculated gradient
n = porosity

In the case of Site 18, for all representative data on Table 3-1, a gradient cannot be calculated properly. The distribution of elevations shows little separation between the water table at 18GW01 and at 18GW02; this slight separation is insufficient to the calculation of gradient and to the construction of groundwater contours.

TABLE 3-2

SUMMARY OF HYDRAULIC CONDUCTIVITY CALCULATIONS
NOVEMBER 1992
NAVAL STATION, ROOSEVELT ROADS, PUERTO RICO

Station	Hydraulic Conductivity Rising Test(1)		Hydraulic Conductivity Falling Test	
	ft/day	cm/sec	ft/day	cm/sec
05GW01	0.86	3.0×10^{-4}	1.2	4.1×10^{-4}
06GW01	0.72	2.5×10^{-4}	0.58	2.0×10^{-4}
R7GW01	0.23	8.1×10^{-5}	0.26	9.2×10^{-5}
R7GW02	0.61	2.2×10^{-4}	0.72	2.5×10^{-4}
R7GW03	0.10	3.5×10^{-5}	0.20	7.1×10^{-5}
R7GW04	0.36	1.3×10^{-4}	0.22	7.8×10^{-5}
R7GW05	--	--	2.9	1.0×10^{-3}
R7GW06	2.2	7.6×10^{-4}	2.3	8.1×10^{-4}
R7GW07	--	--	3.3	1.2×10^{-3}
R7GW08	2.2	7.6×10^{-4}	0.94	3.3×10^{-4}
18GW01	1.3	4.4×10^{-4}	3.3	1.2×10^{-3}
18GW02	0.15	5.3×10^{-5}	--	--
18GW03	0.14	4.9×10^{-5}	--	--

(1) Rising-head tests are usually more reliable under the field conditions encountered at NSRR.

3.1.4 Sampling and Analysis

Sampling addressed the matrices (media) indicated for each site in Section 1.1.3.1. Analyses were made in the field only for the groundwater field parameters (pH, specific conductance and temperature), although each sample was examined by Photo-Ionization Detector (PID) for non-specific releases of volatile organic compounds for the purposes of safety of personnel. The analyses (Section 1.1.3.1) for all other matrices and for groundwater parameters other than the field parameters were made by the chemical laboratory.

All analytical results were of acceptable quality control, except SVOC. SVOC analyses were returned with an instrument detection limit four times the required limit. The SVOC data are still usable in calculating the apparent risk at each site and in verifying the usability of the CS data.

3.2 Investigation Support

The main support for the technical investigations comprised: land navigation; surveying; land-clearing; computer mapping; and correlation of analytical data.

3.2.1 Land Navigation

The land navigation planned for the Supplemental Investigation replaced land surveying of data stations in the most difficult terrain. The position of each data station was recorded by this method.

This navigation was conducted using GPS (Global Positioning System) receivers, as a base station and a remote. Due to the modulation of this system by the Department of Defense, the horizontal resolution of paired, differential receivers is about one meter, the resolution of a single receiver being about 100 meters. The one-meter resolution is sufficient for surveying the horizontal positions of the data stations of the Supplemental Investigation.

3.2.2 Land Surveying

While the GPS receiver is suitable for horizontal control of the positions of the data stations, and can be used where land surveying would be difficult or impossible (the slope at Site 1 and the offshore stations at Site 14), GPS does not provide the accuracy and precision of vertical control require for interpretation of groundwater flow. To this purpose, a licensed surveyor indexed the measuring point of each well used in the Supplemental Investigation to 0.01 feet accuracy against a standard datum.

The surveyor also coordinated the base station for the GPS navigation, allowing reduction of data to a nominal accuracy of one meter.

3.2.3 Land-Clearing

Significant difficulty had been found during the Site Visit in January 1992 in mobility at Sites 1, 5 and 6. Provisions were, therefore, made for limited land-clearing during the field program, by hand at Site 1 and by heavy equipment at Sites 5 and 6. Land-clearing involved minimal disturbance of the ground-cover, but resulted in access lanes extending adequately over the study areas of each site.

3.2.4 Computer Mapping

The land navigation by GPS receiver is compatible with computer-assisted drafting (CAD). Following reduction of induced error, the CAD constructed scaled, schematic diagrams of each site from the GPS data. These schematic maps, referenced in Section 4, are accurate for locations of data stations and access trails to a nominal radius of one meter. All data stations, certain access trails and all geophysical traverse lines have been plotted by this method.

3.2.5 Correlation of Analytical Data

Appendix 3.D presents the results of chemical analyses provided by the Confirmation Study (CS). The tables in this appendix present information only on the compounds quantified during the CS. An effort was made during the Supplemental Investigation to correlate these data with more current information to evaluate the usefulness of these CS data.

3.3 Chronologic Log of Field Activities

Six members of the field team traveled to the site on October 29, 1992; one arrived on November 2, 1992, with the last on November 10, 1992. Six of the team left on November 25, 1992, while two remained until December 2 and 7, 1992 to replace shipping casualties to the laboratory and to complete demobilization. A Chronologic Log of relevant activities appears in Appendix 3.E.

3.4 Special Conditions

The field program of the Supplementary Investigation at NSRR involved certain special conditions reflecting terrain and mobility, and mapping limitations.

3.4.1 Terrain and Mobility Limitations

The dense tropical (jungle-like) vegetation was a deterrent to collecting environmental samples. Site access was impossible without the need of thorough tree and brush clearing to permit the sampling teams to reach the sampling points and obtain the prescribed samples. Due to the tropical climatic conditions and rapid regrowth of vegetation, it is virtually impossible to resample areas without reclearing a path to the sampling locations. Needless to say, all sampling equipment and samples had to be manually transported thorough the jungle.

At Sites 1, 5, 6 and 14, the terrain presented severe mobility obstacles, which detrimentally affected the ability to locate and collect environmental samples. At Sites 1, 5 and 6, the overgrowths of vegetation are sufficient to prevent movement without land-clearing. Mobility is further restricted at Site 1 by the steepness of the side of the ravine on which the site is located and the presence of an endangered/protected species of insect; at Site 5, by the steepness of the sides of the knoll on which the disposal areas are located; and at Site 6, by the instability of the saturated (boggy) ground. Movement around Site 14 is limited to the use of small-boats of shallow draft in the tidal margin of the overhanging mangroves; overland access cannot reach the interior of the mangroves from the land-side, and larger boats approaching from the harbor-side will ground in the shoals or be trapped by the overhang of mangrove.

The dense, tropical forests of Sites 1, 5 and 6 have an occasional to frequent distribution of trees (greater than 20 feet in height). The dominant characteristic of these sites, however, is

the impenetrable entanglement of low to moderate shrubs (three to twenty feet in height) with a dense mantle of encroaching vines. Off the boundary roads, these sites can only be entered after landclearing; it is impossible merely to walk into the sites for useful work (whether sampling or mapping). Access was gained at Site 1 by laborious cutting of narrow trails by hand; and at Site 5 and 6, by use of an NSRR bulldozer. Only parts of the disposal areas of Sites 1 and 5 could be cleared by the available methods.

3.4.2 Mapping Limitations

There are no detailed maps available of any of the subject sites with usable horizontal or vertical control. Available mapping includes the schematic diagram used as the Station Base Map by the Public Works Office, nondimensional sketches from the IAS and CS, and overlay mapping from the GPS navigation survey. These sources were variably combined at particular sites for the mapping of the Supplemental Investigation.

Unfortunately, the scales and orientations (horizontal controls) of the mapping sources are incompatible. Therefore, there are discrepancies in the overlay of GPS stations on the NSRR Base Map. This is represented on Figure 1-9 for Site 7. The GPS coordinates for the data stations (Appendix 3.F) are accurate to within a nominal radius of one meter, and can be reoccupied precisely by GPS navigation. However, since the horizontal data of the GPS and the NSRR Base Map are not compatible, a shift in horizontal position is artificially induced. For example, monitor well R7GW06 is located by GPS across the road from its actual position on the ground. The GPS position of R7GW06 (without GPS mapping of the road, or coordination of the horizontal controls of the GPS and NSRR maps) can only be used for navigation or mapping by GPS; without GPS navigation, location of R7GW06 must be accomplished in the field by inspection of the ground rather than map-reference.

Where the NSRR Base Map has been used, the representations for certain sites are only schematic. Features noted on the NSRR Base Map were not verified in the field during the Supplementary Investigation, although some are strongly suspected of being misrepresented on the Base Map. Consequently, the sections of the NSRR Base Map used for certain sites have been edited slightly for clarity of presentation.

Regardless of the sources used in preparing the site maps for the Supplementary Investigation, no vertical control is available. Therefore, no contour lines appear accurately on any map.

4.0 NATURE AND EXTENT OF CONTAMINATION

This section of the Supplemental Investigation report describes the findings of the investigations regarding the nature and extent of contamination. An initial discussion of the field parameters measured during the site investigations leads to a detailed discussion of analytical results (for the various environmental media sampled) on a "by-site" basis. Finally, one of the aims of the Supplemental Investigation was to provide analytical data that would either prove the results of testing done during the confirmation study were representative of site conditions or refute the interpretive indications of these data. This topic is discussed in the fron subsection of this section.

4.1 Mapping and Description of Sites

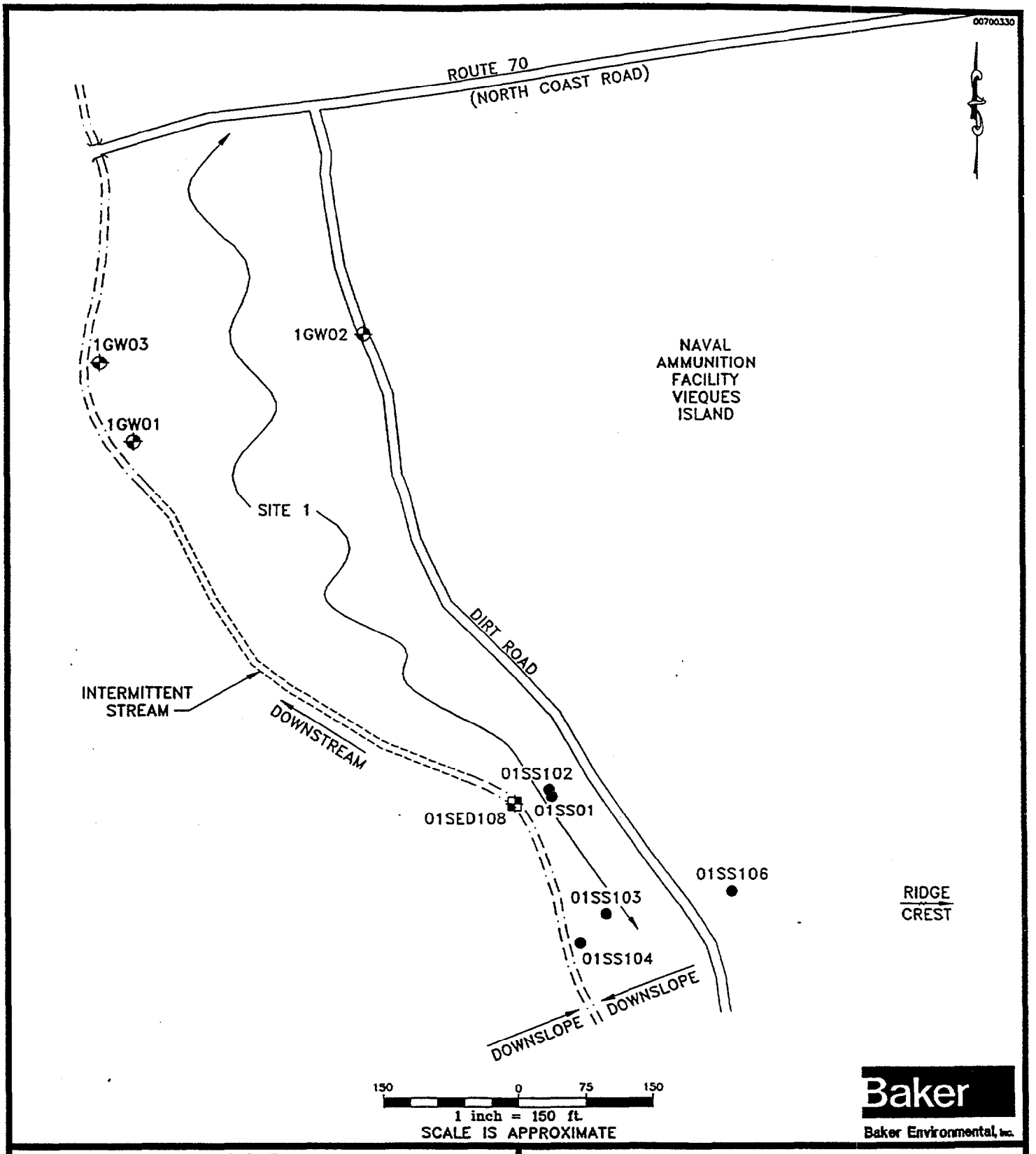
The physical descriptions of the individual sites appear in Section 1.2.3; the schematic diagrams of the sites and the sampling stations appear on:

Site 1	Figures 1-4 and 4-1
Site 2	Figures 1-5 and 4-2
Site 5	Figures 1-7 and 4-3
Site 6	Figures 1-8 and 4-4
Site 7	Figures 1-9 and 4-5
Site 10	Figures 1-10 and 4-6
Site 13	Figures 1-11 and 4-7
Site 14	Figures 1-12 and 4-8
Site 16	Figures 1-13 and 4-9
Site 18	Figures 1-14 and 4-10
Site 21	Figures 1-15 and 4-11

The aerial mapping of the sites appears in Appendix 3.A, while the geophysical profiling of Site 5 appears in Appendix 3.B. Appendix 3.F contains summaries of the positions of data stations and access traverses from the GPS mapping and the report of the land surveyor.

4.2 Field Parameters

The field parameters (pH - chemical activity of ionic hydrogen; Sc - specific conductance; and T - temperature) were measured in the field at the well-head at the time of sampling. The representative values appear on Table 4-1. The relevant dates of the initial sampling at the particular sites are: Site 5 - November 19, 1992; Site 6 - November 19, 1992; Site 7 - November 18, 1992; and Site 18 - November 11, 1992.

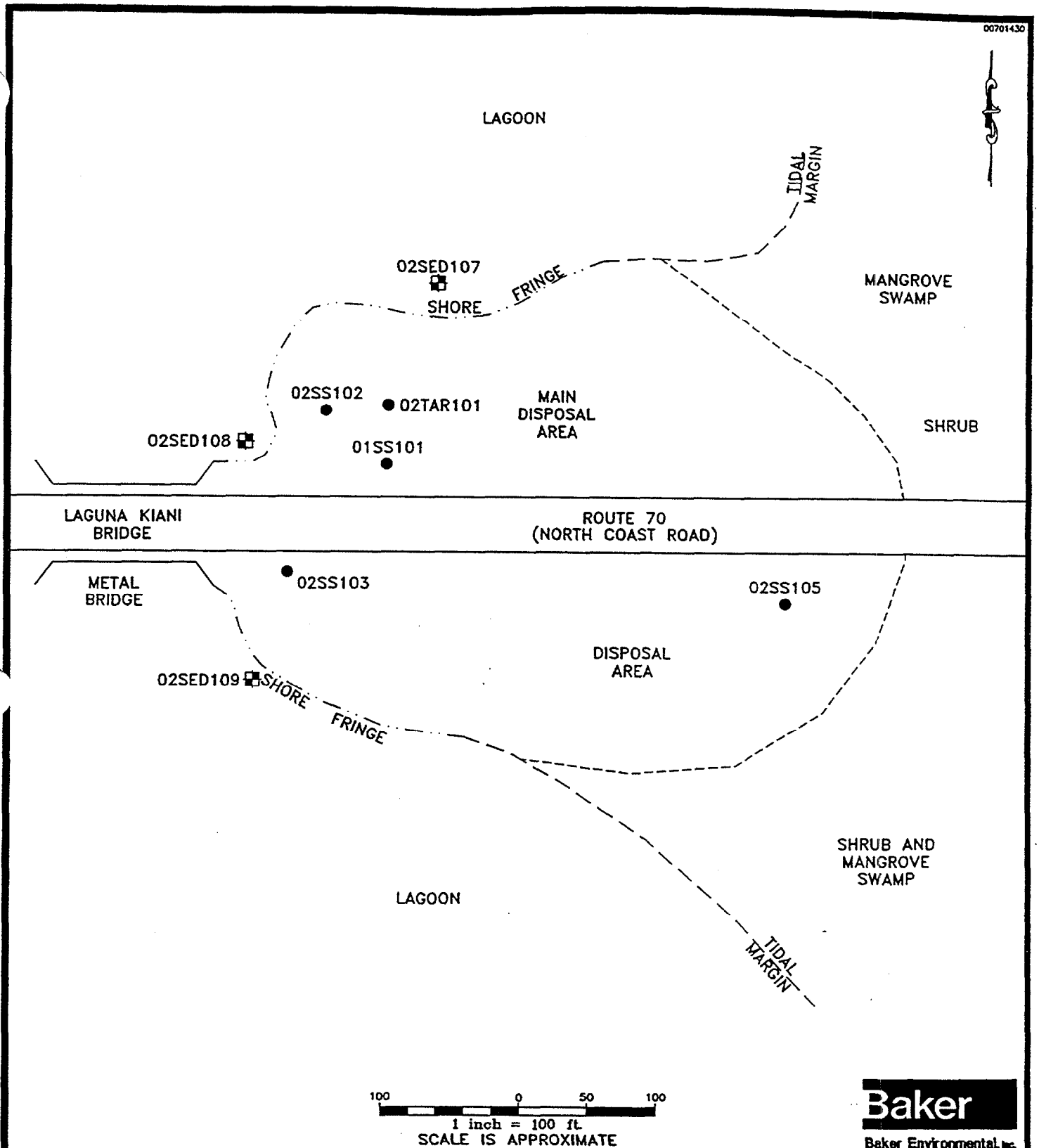


LEGEND

1GW01	MONITORING WELL LOCATION
01SED108	SURFACE WATER/SEDIMENT SAMPLE LOCATION
01SS102	SOIL SAMPLE LOCATION

SOURCE: BAKER ENVIRONMENTAL GPS SURVEY, NOV. 1992

FIGURE 4-1
DATA STATIONS
SITE 1
QUEBRADA DISPOSAL SITE
VEIQUES ISLAND
NAVAL STATION ROOSEVELT ROADS
PUERTO RICO



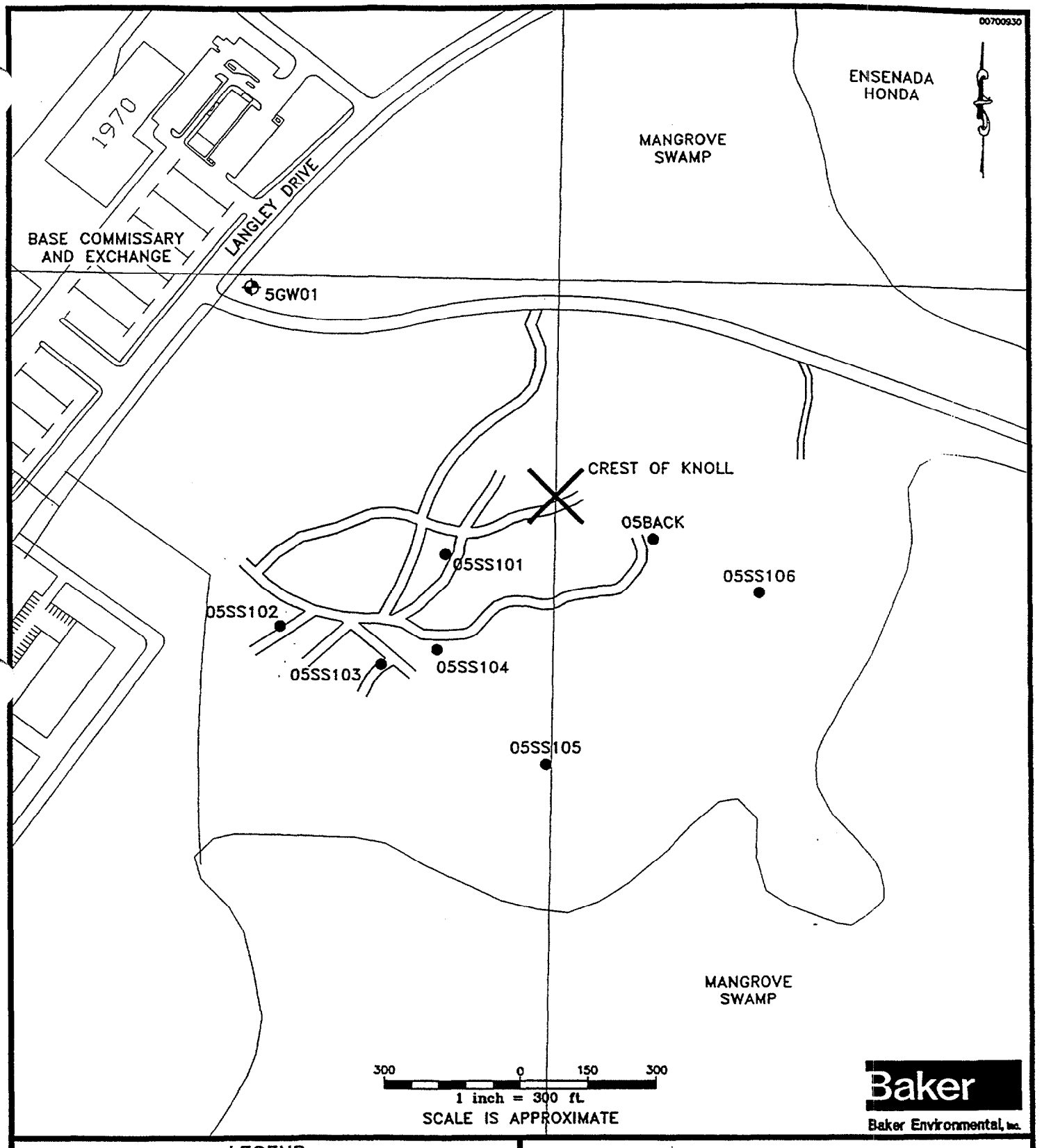
LEGEND

02SED108 SURFACE WATER/SEDIMENT SAMPLE LOCATION

02SS102 SOIL SAMPLE LOCATION

SOURCE: BAKER ENVIRONMENTAL GPS SURVEY, NOV. 1992

FIGURE 4-2
DATA STATIONS
SITE 2
MANGROVE DISPOSAL SITE
VIEQUES ISLAND
NAVAL STATION ROOSEVELT ROADS
PUERTO RICO



LEGEND

5GW01 — MONITORING WELL LOCATION

05SS102 — SOIL SAMPLE LOCATION

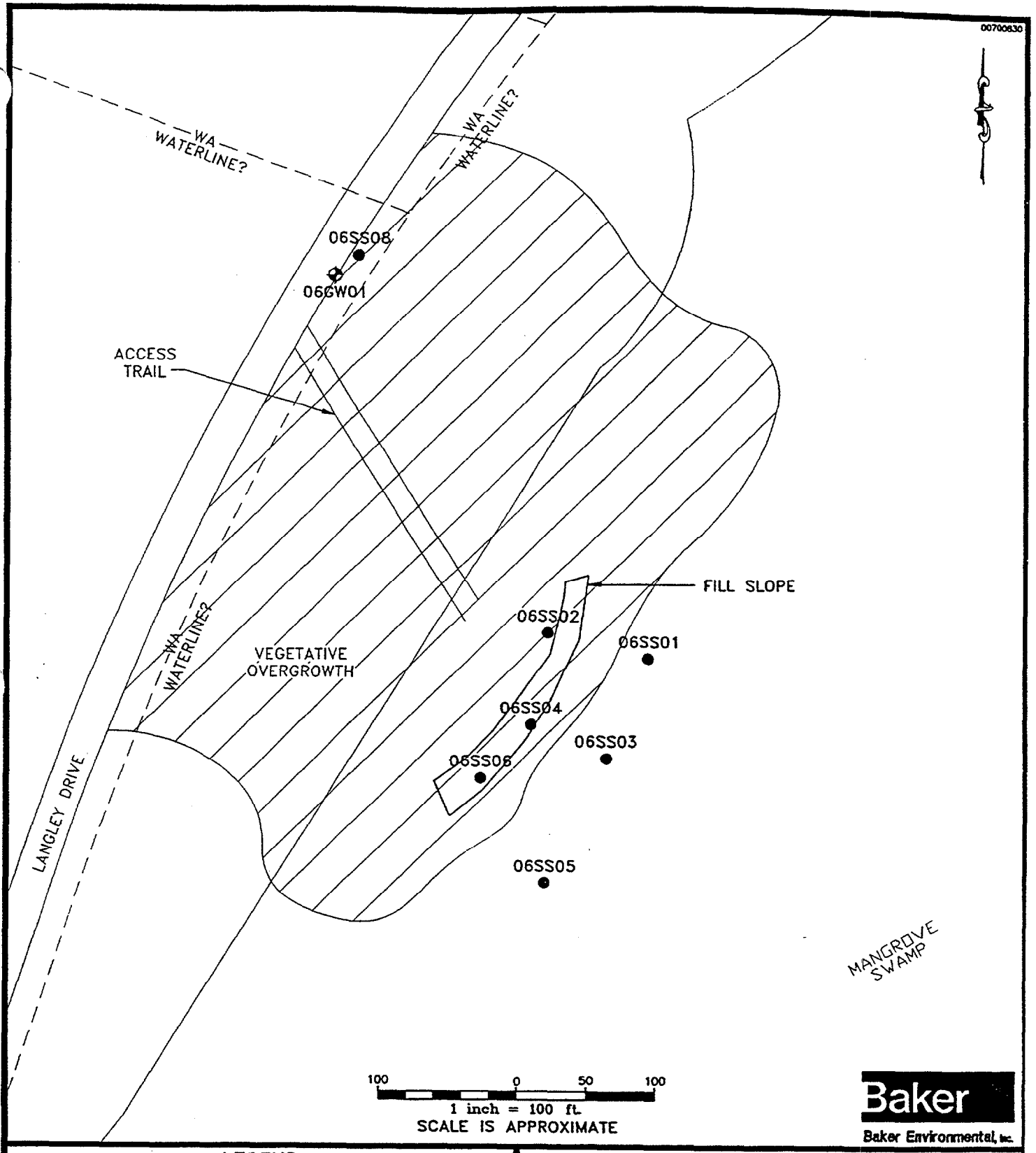
CLEARED ACCESS LANE

1970 — STATION STRUCTURE

NOTED FEATURES TRANSFERRED FROM AIR-PHOTO INTERPRETATION

SOURCE: STATION PUBLIC WORKS BASE MAP, FEB. 1992
SOURCE: BAKER ENVIRONMENTAL GPS SURVEY, NOV. 1992

FIGURE 4-3
DATA STATIONS
SITE 5
ARMY CREMATOR
DISPOSAL AREA
NAVAL STATION ROOSEVELT ROADS
PUERTO RICO



LEGEND

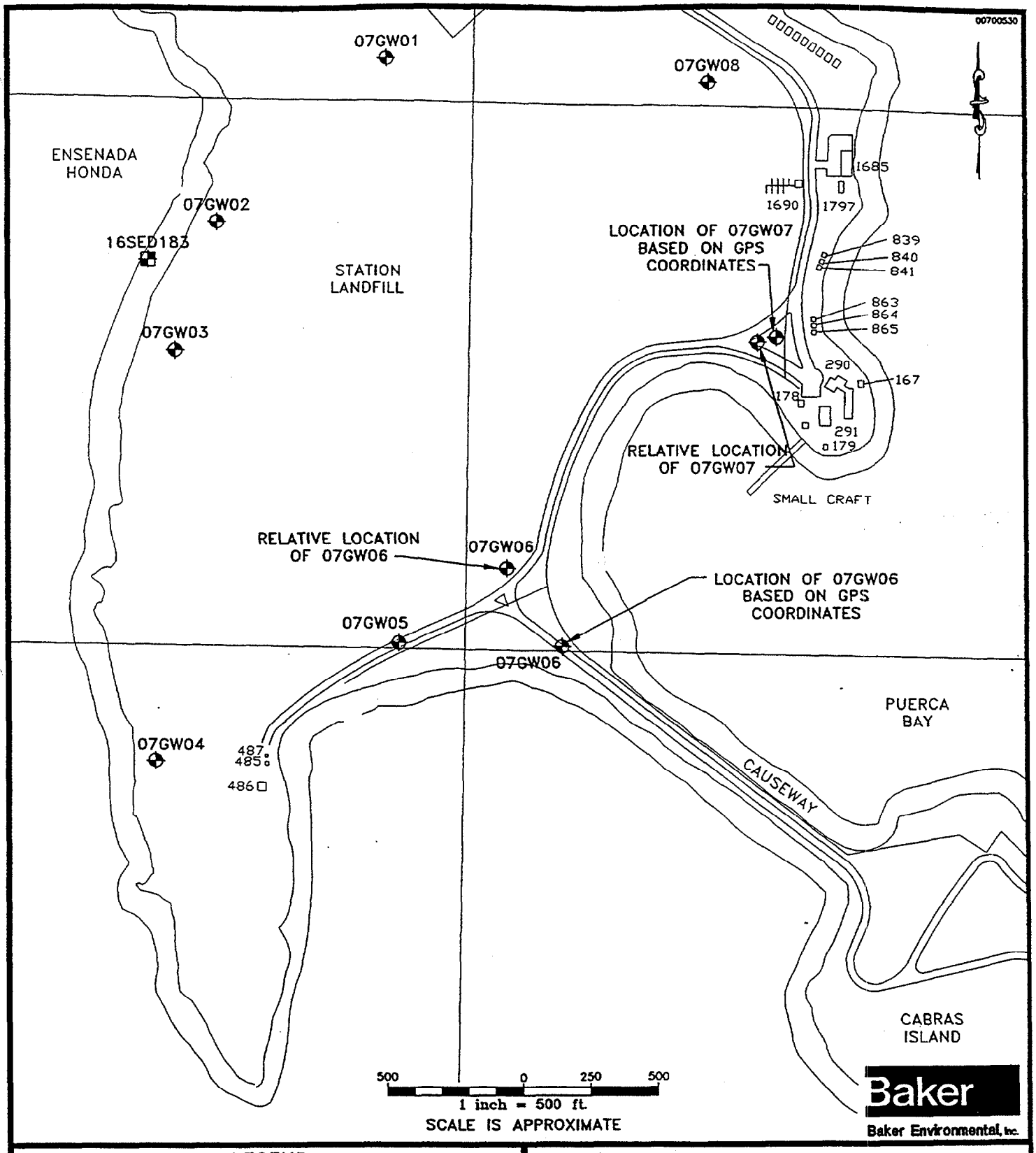
06GW01 MONITORING WELL LOCATION

06SS102 SOIL SAMPLE LOCATION

NOTED FEATURES TRANSFERRED FROM AIR-PHOTO INTERPRETATION

SOURCE: STATION PUBLIC WORKS BASE MAP, FEB. 1992
SOURCE: BAKER ENVIRONMENTAL GPS SURVEY, NOV. 1992

FIGURE 4-4
DATA STATIONS
SITE 6
LANGLEY DRIVE
DISPOSAL SITE
NAVAL STATION ROOSEVELT ROADS
PUERTO RICO



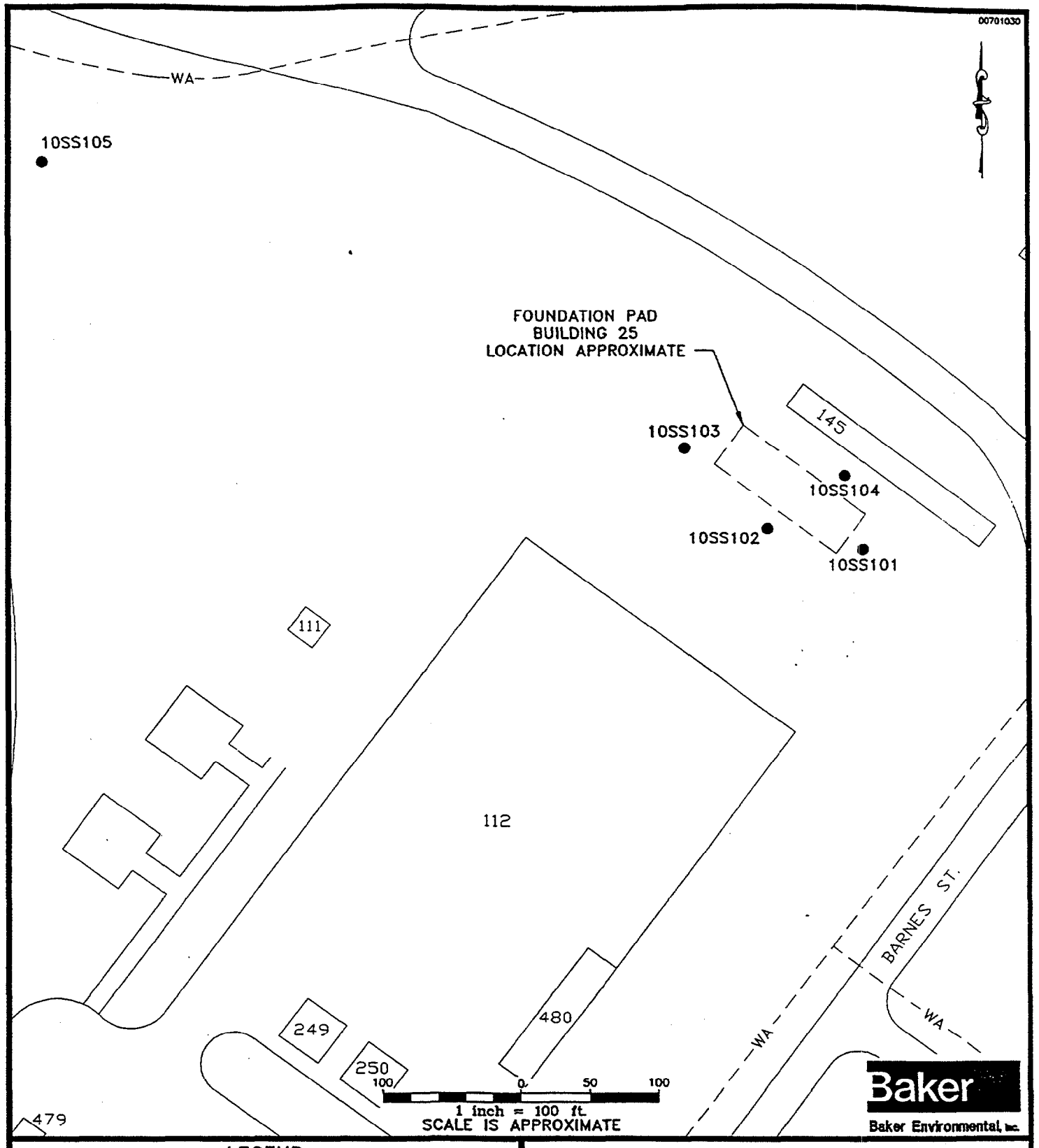
LEGEND

07GW01	MONITORING WELL LOCATION
16SED183	SURFACE WATER/SEDIMENT SAMPLE LOCATION
290	STATION STRUCTURE

SOURCE: STATION PUBLIC WORKS BASE MAP, FEB. 1992
SOURCE: BAKER ENVIRONMENTAL GPS SURVEY, NOV. 1992

FIGURE 4-5
DATA STATIONS
SITE 7
STATION LANDFILL

NAVAL STATION ROOSEVELT ROADS
PUERTO RICO



LEGEND

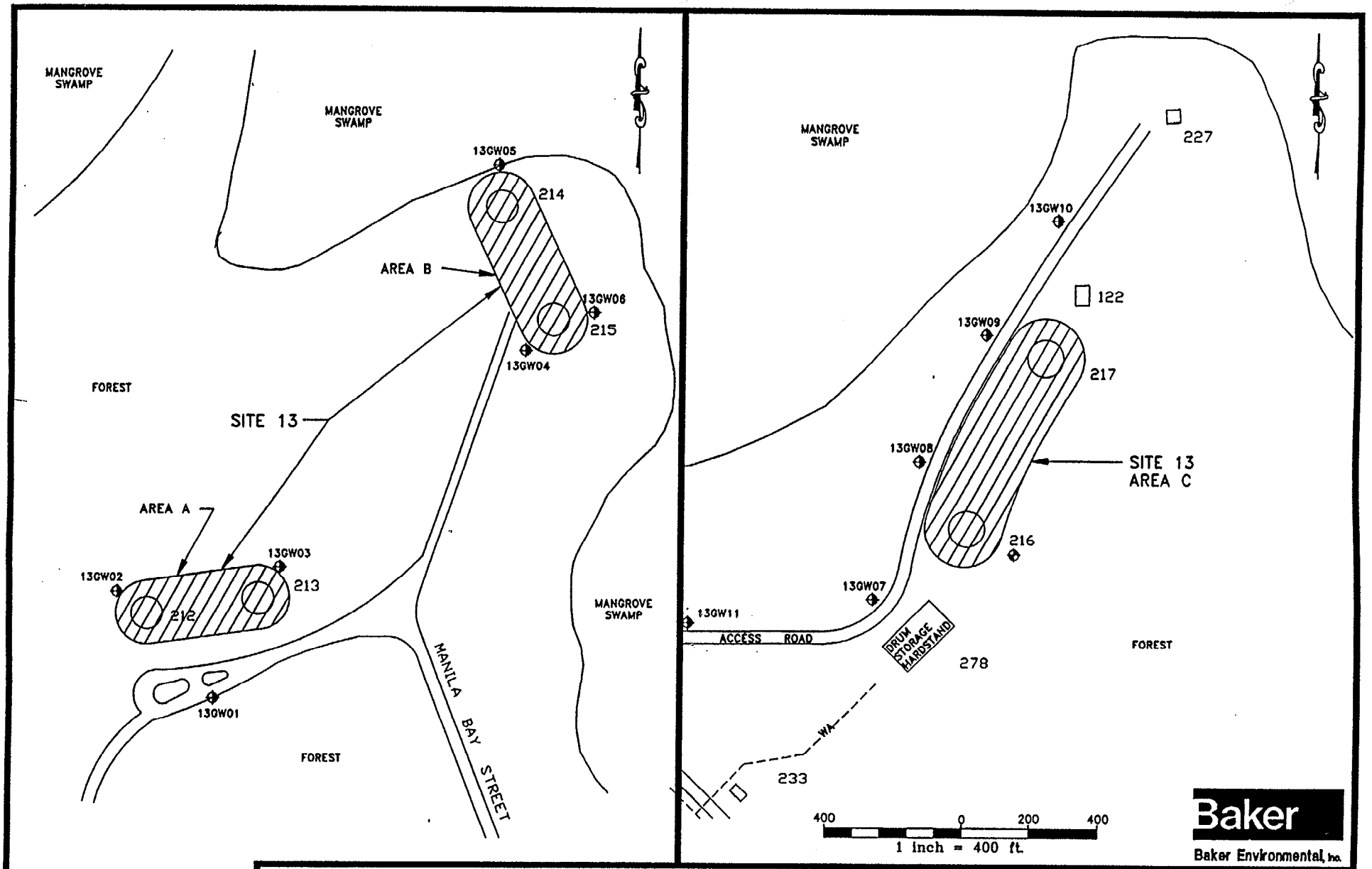
10SS102 ● SOIL SAMPLE LOCATION

249 STATION STRUCTURE

—WA— — — WATERLINE?

SOURCE: STATION PUBLIC WORKS BASE MAP, FEB. 1992
SOURCE: BAKER ENVIRONMENTAL GPS SURVEY, NOV. 1992

FIGURE 4-6
DATA STATIONS
SITE 10
BUILDING 25
STORAGE AREA
NAVAL STATION ROOSEVELT ROADS
PUERTO RICO



LEGEND

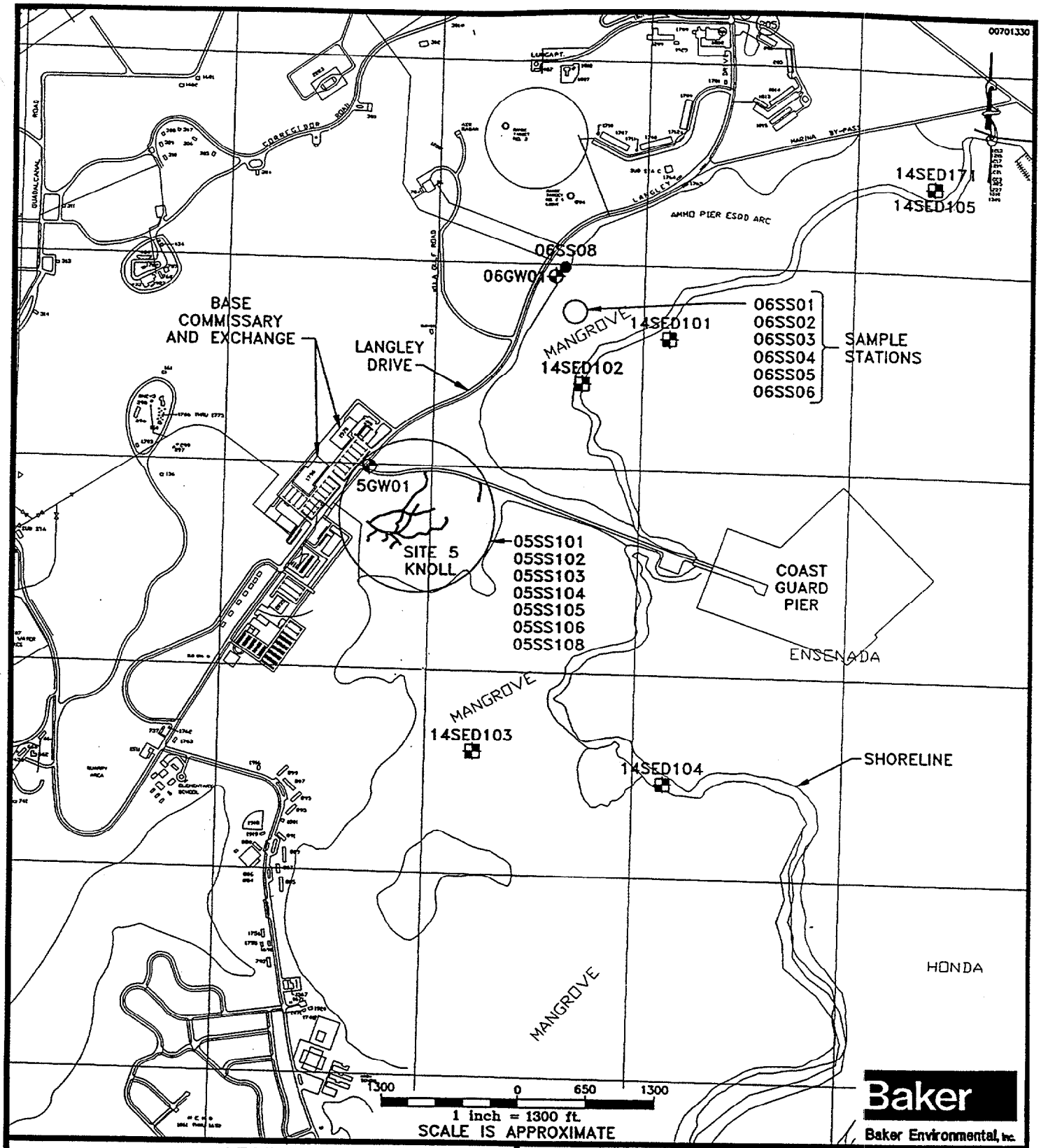
◆ MONITORING WELL LOCATION

233 □ STATION STRUCTURE

SOURCE: STATION PUBLIC WORKS BASE MAP, FEB. 92

00702730

FIGURE 4-7
DATA STATIONS
SITE 13
TANKS 210-217
NAVAL STATION ROOSEVELT ROADS
PUERTO RICO



LEGEND

06GW01 — MONITORING WELL STATION

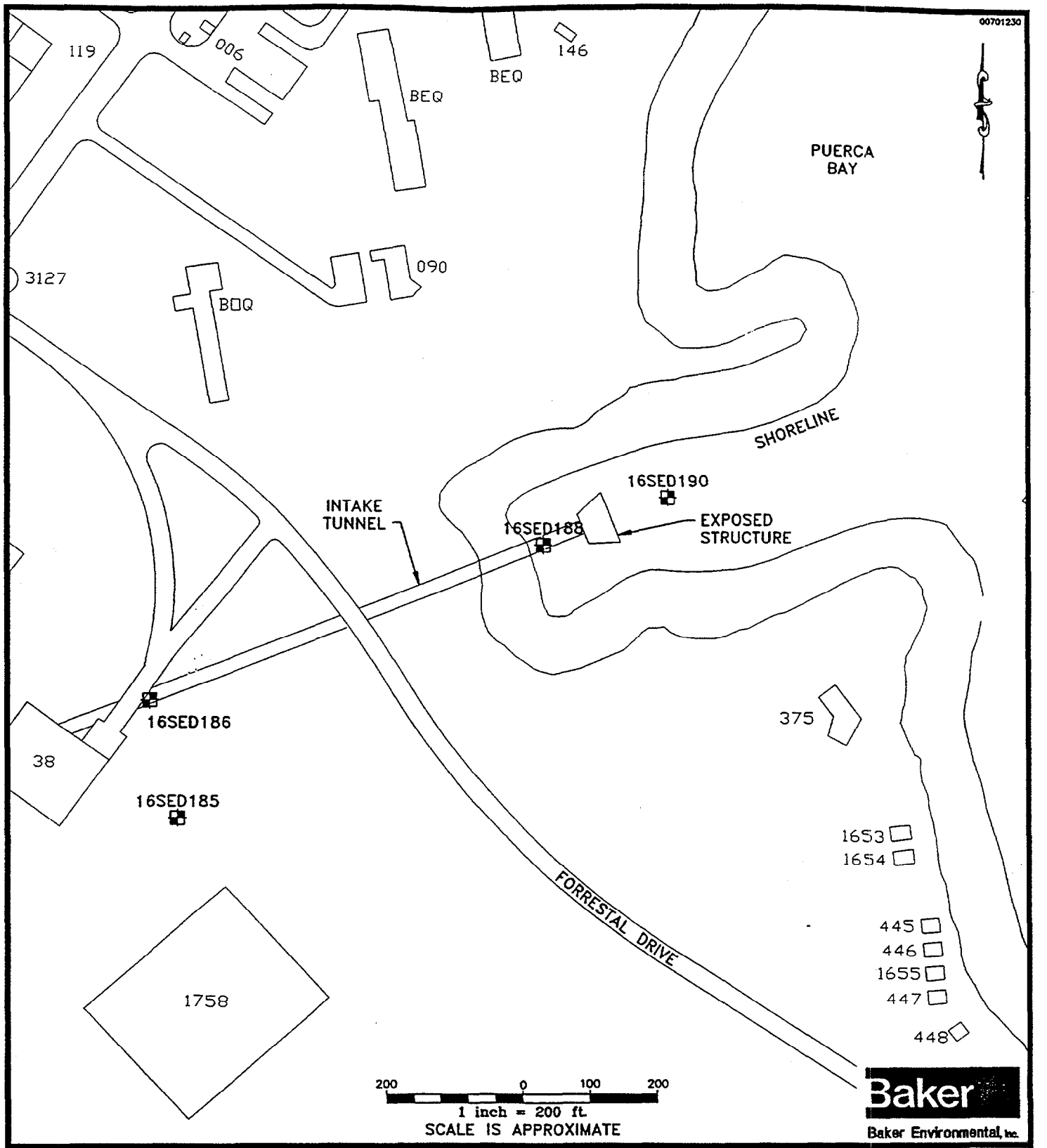
14SED103 — SURFACE WATER/SEDIMENT SAMPLE STATION

06SS08 — SOIL SAMPLE STATION

1511 — STATION STRUCTURE

SOURCE: STATION PUBLIC WORKS BASE MAP, FEB. 1992
SOURCE: BAKER ENVIRONMENTAL GPS SURVEY, NOV. 1992

FIGURE 4-8
DATA STATIONS
SITE 14
ENSENADA HONDA SHORELINE
AND MANGROVES
NAVAL STATION ROOSEVELT ROADS
PUERTO RICO



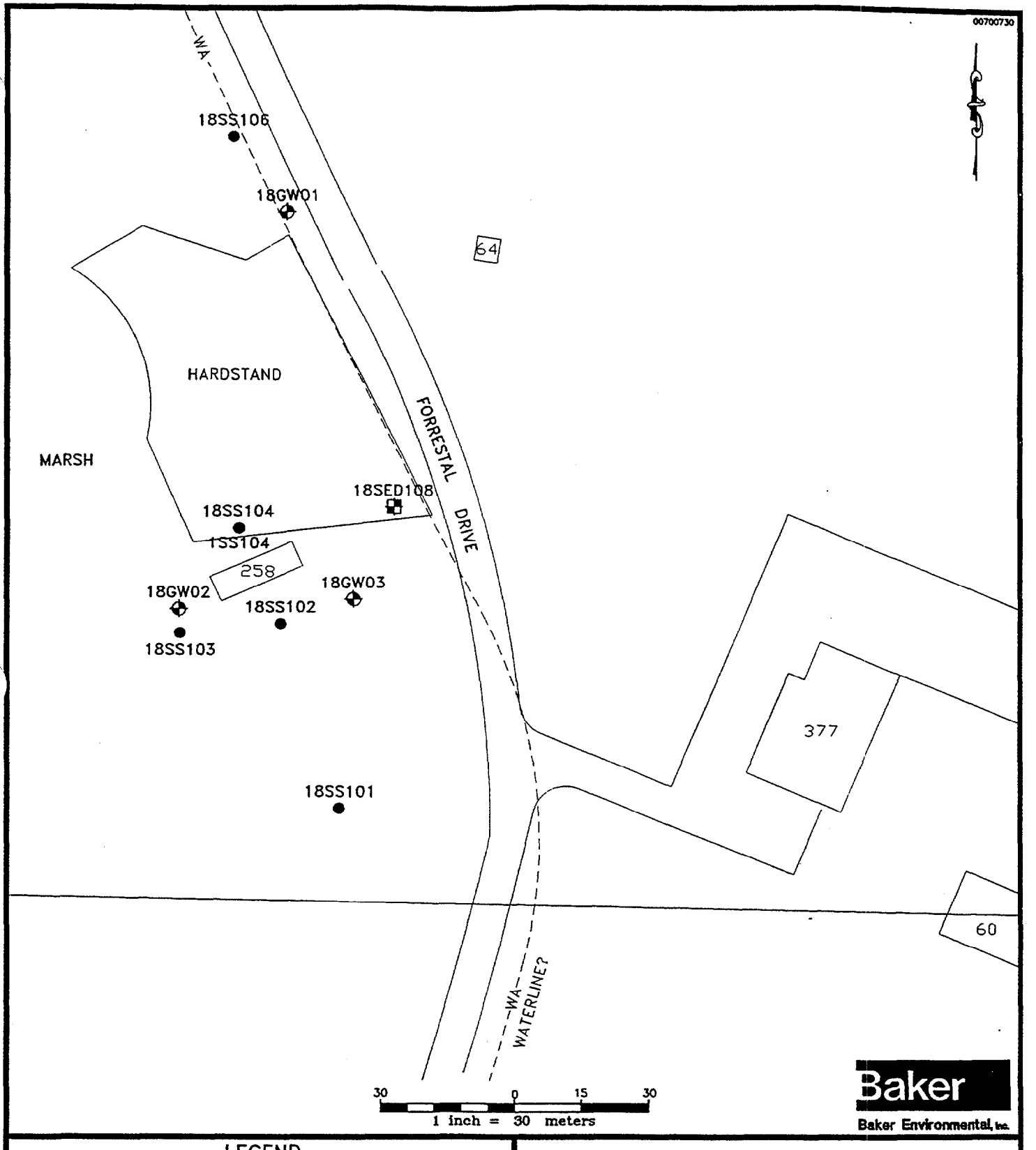
LEGEND

16SED185 SURFACE WATER/SEDIMENT SAMPLE STATION

38 STATION STRUCTURE

SOURCE: STATION PUBLIC WORKS BASE MAP, FEB. 1992
SOURCE: BAKER ENVIRONMENTAL GPS SURVEY, NOV. 1992

FIGURE 4-9
DATA STATIONS
SITE 16
OLD POWER PLANT
BUILDING 38
NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

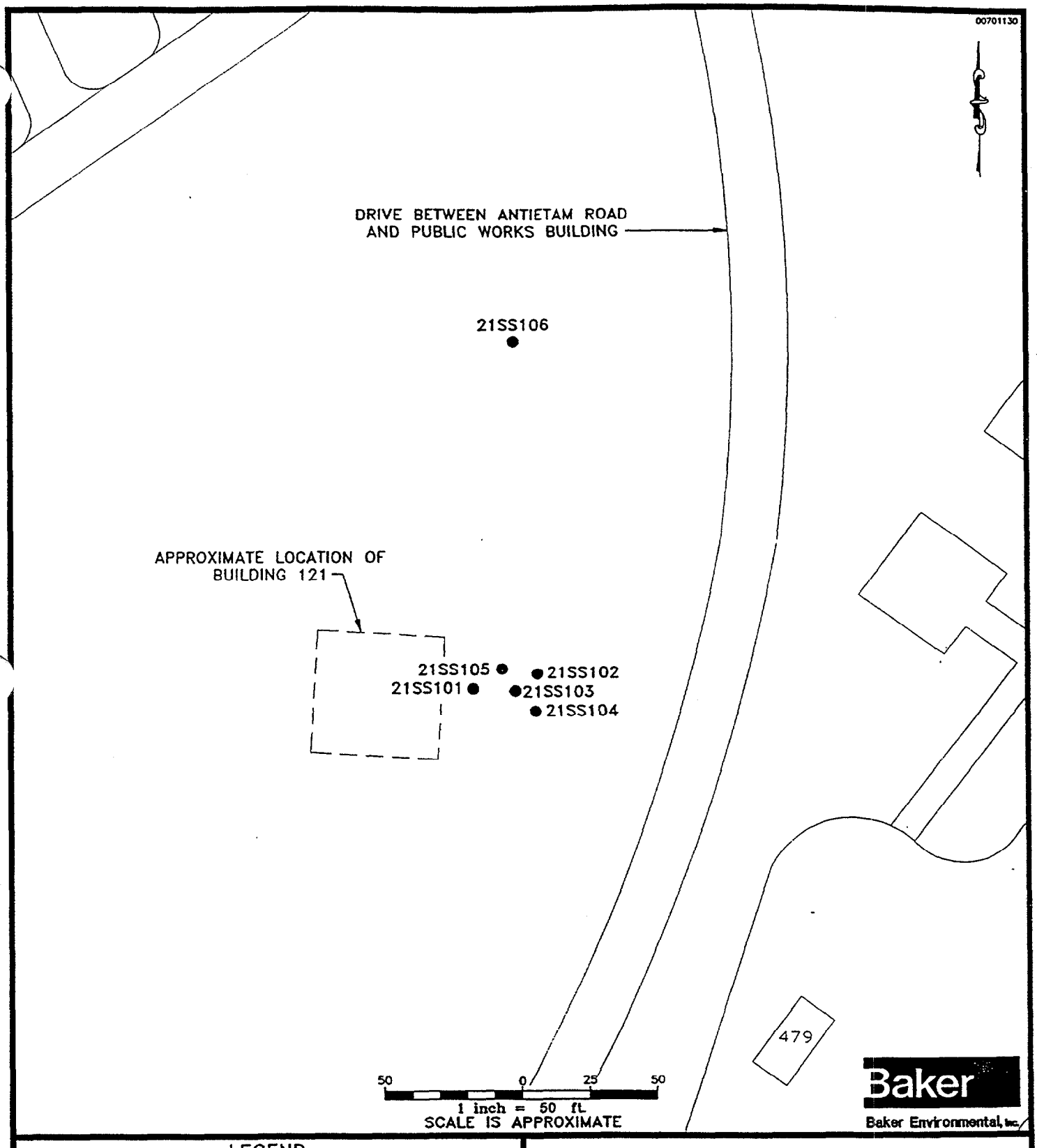


LEGEND

18GW01	MONITORING WELL LOCATION
18SED108	SURFACE WATER/SEDIMENT SAMPLE LOCATION
18SS102	SOIL SAMPLE LOCATION
64	STATION STRUCTURE

SOURCE: STATION PUBLIC WORKS BASE MAP, FEB. 1992
SOURCE: BAKER ENVIRONMENTAL GPS SURVEY, NOV. 1992

FIGURE 4-10
DATA STATIONS
SITE 18
PEST CONTROL SHOP AND
SURROUNDING AREAS
NAVAL STATION ROOSEVELT ROADS
PUERTO RICO



LEGEND

21SS102 ● SOIL SAMPLE LOCATION

479 STATION STRUCTURE

SOURCE: STATION PUBLIC WORKS BASE MAP, FEB. 1992
SOURCE: BAKER ENVIRONMENTAL GPS SURVEY, NOV. 1992

FIGURE 4-11
DATA STATIONS
SITE 21
OLD PESTICIDE STORAGE
BUILDING 121
NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

TABLE 4-1

SUMMARY OF FIELD PARAMETERS
NAVAL STATION, ROOSEVELT ROADS, PUERTO RICO

Station	November 10, 1992			November 11, 1992			November 18, 1992		
	pH	SC	T	pH	SC	T	pH	SC	T
05GW01					5,000	29.0			
06GW01					4,500	30.0			
R7GW01							6.88 6.92 6.94	14,500 14,500 14,800	30.1 30.0 30.1
R7GW02		9,000	28.0				7.33 7.34 7.45	10,000 10,000 10,000	28.1 27.6 27.6
R7GW03		45,000	28.0				7.09 7.27 7.13	38,500 38,500 38,500	28.4 28.3 27.9
R7GW04		48,500	28.0				6.61 6.88 6.98	48,000 48,000 48,000	29.5 29.6 29.0
R7GW05		18(1)	32.0				6.89 6.85 6.82	19,000 19,000 19,000	31.9 32.0 32.0
R7GW06		20(1)	30.0				7.05 7.04 7.06	5,000 4,395 4,250	30.0 30.0 29.2
R7GW07		8(1)	32.0				7.32 7.33 7.32	2,050 2,000 2,100	29.5 32.0 31.0
R7GW08		28(1)	30.0				7.49 7.49 7.50	>50,000 >50,000 >50,000	30.0 29.5 29.8
18GW01					12,500	29.0	6.98 6.97 6.98 7.00	9,700 12,000 12,500 12,500	28.8 28.8 29.1 28.9
18GW02					23,000	27.0	6.42 6.49 6.64	26,000 26,500 27,000	29.0 27.7 28.0
18GW03					1,000	29.0	7.91 7.60 7.73	1,000 1,000 1,000	24.6 29.0 29.0

TABLE 4-1 (Continued)

SUMMARY OF FIELD PARAMETERS
NAVAL STATION, ROOSEVELT ROADS, PUERTO RICO

Station	November 19, 1992			November 24, 1992			December 1, 1992		
	pH	SC	T	pH	SC	T	pH	SC	T
05GW01	7.01 6.62 7.25	5,500 5,500 5,000	31.0 31.0 31.0				6.97 7.02 7.01	6,000 6,000 6,000	28.5 28.5 28.5
06GW01	7.09 7.09 7.46	3,100 3,900 3,100	33.0 33.0 33.0						
R7GW01									
R7GW02									
R7GW03				7.06 7.08 7.08	200(1) 200(1) 190(1)	27.9 27.8 27.8			
R7GW04									
R7GW05									
R7GW06				6.94 6.97 6.97	12,000 10,500 10,500	28.5 29.1 29.3			
R7GW07									
R7GW08									
18GW01				6.95 6.94 6.96	12,000 12,030 12,050	28.5 28.0 27.8			
18GW02									
18GW03				7.52 7.60 7.62	1,000 1,000 1,000	30.0 31.0 32.0			

Notes: SC = Specific Conductivity in µmhos/cm at ambient temperature.
T = Temperature (°C)
(1) Instrument error.

The higher readings of Sc (at all stations except 18GW03) reflect the relative influence of brackish or saline water at the coastal margin (near a shoreline or near the inland edge of a mangrove swamp). The reading of 1000 millimhos/centimeter at 18GW03 is within the range of freshwater with very high TDS (total dissolved solids).

The readings of pH and T are unremarkable.

All values cited are representative of the trends noted during the field investigation.

4.3 Results of Site-Specific Laboratory Analyses

The descriptions of this section list, for convenient reference, only the compounds quantified or detected in particular matrices at the individual sites. The significance of the detections is discussed, and the overall results of chemical analyses are assessed in detail in Section 5.

The sites described in Section 1.1.3.1 (RFI Design - Sites 1, 2, 5, 6, 10, 14 and 18) are included in this presentation and in the discussions of Section 5. As indicated previously, the disposition of Site 13 (Section 1.1.3.2, Relief From RFI Design - Site 13) requires no further discussion; the data for the sites described in Section 1.1.3.3 (Non-RFI Information - Sites 7, 16 and 21) have been transferred to the relevant programs. The listing of data stations and sample numbers appears in Appendix 4.A; the reports of chemical analyses appear in Appendix 4.B. The following abbreviations are used throughout this section:

VOC	volatile organic compounds of the Target Compound List (TCL)
SVOC	semivolatile organic compounds of the TCL
P/PCB	pesticide and polychlorinated biphenyl compounds of the TCL
TAL	metals and cyanide of the Target Analyte List

4.3.1 Site 1 - Quebrada Disposal Site, Vieques Island

Tables 4-2 and 4-3 summarize the quantified values of compounds detected in the samples of Site 1 from the Supplemental Investigation. These values indicate the conditions that are described in the following sections.

TABLE 4-2

ORGANIC COMPOUNDS DETECTED IN THE SOIL AND SEDIMENT

SITE 1 - NAVAL STATION ROOSEVELT ROADS

PUERTO RICO

SAMPLE ID	01 SS 101	01 SS 102	01 SS 103	01 SS 104	01 SS 105DUP (01 SS 104)	01 SS 106	01 SS 107
UNITS	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg
VOLATILES							
Acetone	12 U	29 J	60 J	98	12 U	12 U	100
Carbon disulfide	5 U	6 U	22	59	25	13	13
Toluene	19	7 U	11 UJ	52	8 U	16 U	48
PESTICIDES/PCB'S							
Aroclor-1260	R	R	R	160 UJ	4.9 UJ	25 J	NA
Chlordane,alpha-	R	R	R	8 UJ	0.25 UJ	0.26 UJ	NA
DDD,4,4-	R	R	R	16 UJ	0.49 UJ	0.51 UJ	NA
DDE,4,4-	R	R	R	16 UJ	0.49 UJ	0.51 UJ	NA
SEMIVOLATILES							
Bis(2-ethylhexyl)phthalate	1500 U	400 J	1600 U	1500 U	430 J	440 J	500 J
Butylbenzylphthalate	1500 U	1600 U	360 J	100 J	1500 U	1500 U	1600 U
Di-n-butylphthalate	200 J	270 J	270 J	320 J	1500 U	1500 U	340 J

Qualifiers:

J - estimated value

NA - not analyzed

R - result is rejected and unusable

U - undetected value

UJ - reported quantitation limit is estimated

TABLE 4-2 (CONTINUED)

ORGANIC COMPOUNDS DETECTED IN THE SOIL AND SEDIMENT
SITE 1 - NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

SAMPLE ID	01 SS 108	01 SS 109	01SS110C Background	01SS110D Background	01SS110E Background	01SED 111
UNITS	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg
VOLATILES						
Acetone	10 U	72	NA	NA	NA	54
Carbon disulfide	2 J	29	NA	NA	NA	5 U
Toluene	10 U	32 J	NA	NA	NA	6 U
PESTICIDES/PCB'S						
Aroclor-1260	4.8 UJ	3.9 UJ	4.2 UJ	3.9 UJ	5 UJ	4.5 UJ
Chlordane,alpha-	0.25 UJ	0.2 UJ	0.22 UJ	0.2 UJ	0.43 J	0.23 UJ
DDD,4,4-	0.48 UJ	0.39 UJ	0.42 UJ	0.39 UJ	17 J	0.45 UJ
DDE,4,4-	0.48 UJ	0.39 UJ	0.42 UJ	0.39 UJ	1.7 J	0.45 UJ
SEMIVOLATILES						
Bis(2-ethylhexyl)phthalate	430 J	490 J	NA	NA	NA	800 J
Butylbenzylphthalate	1500 U	1400 U	NA	NA	NA	100 J
Di-n-butylphthalate	260 J	290 J	NA	NA	NA	280 J

Qualifiers:
J - estimated value
NA - not analyzed
R - result is rejected and unusable
U - undetected value
UJ - reported quantitation limit is estimated

TABLE 4-3

INORGANIC CHEMICALS DETECTED IN THE SOIL AND SEDIMENT

SITE 1 - NAVAL STATION ROOSEVELT ROADS

PUERTO RICO

SAMPLE ID	01 SS 101		01 SS 102		01 SS 103		01 SS 104		01 SS 105DUP (01 SS 104)		01 SS 106		01 SS 107	
UNITS	mg/Kg		mg/Kg		mg/Kg		mg/Kg		mg/Kg		mg/Kg		mg/Kg	
Aluminum	13300		11400		11800		7810		10000		12600		13400	
Antimony		R		R		R		R		R		R		R
Arsenic	0.71	U	0.73	U	0.73	U	0.7	U	0.97	B	0.74	U	0.74	U
Barium	131		91.7		99.3		70.3		70.2		101		107	
Beryllium	0.19	B	0.36	B	0.55	B	0.17	B	0.3	B	0.71	B	0.74	B
Cadmium	0.66	U	0.74	B	0.97	B	0.66	B	0.98	B	1.5		1.6	
Calcium	5630		5440		8700		5720		7070		5720		5770	
Chromium	42.1		62.1		45.7		25.2		37		53.5		51.1	
Cobalt	13.9		18.4		19.3		14.6		13.1		24.1		23.7	
Copper	24.5	J	44.4	J	39.8	J	26	J	36.4	J	58.4	J	49	J
Iron	13200		19100		24100		15000		21200		27200		27400	
Lead	0.42	UJ	0.44	UJ	8.2		7.1		33.6		8.7		23.1	
Magnesium	7140		9920		7050		6320		6130		6700		6570	
Manganese	509		690		1040		622		608		769		914	
Nickel	35.5		40.1		26.3		17.1		20.6		28.6		27.8	
Potassium	302		181		619		934		1110		562		624	
Selenium	0.57	UJ	0.58	UJ	0.59	UJ	0.56	UJ	0.92	J	0.59	UJ	0.59	UJ
Silver	1.7	J	1.5	UJ	1.5	UJ	1.7	J	1.7	J	2.3	J	1.6	J
Sodium	562	B	508	B	691	B	376	B	532	B	870	B	843	B
Vanadium	34.4	J	63.7	J	91.4	J	54.8	J	70.9	J	118	J	120	J
Zinc	23.7	J	35.3	J	56.6	J	50.8	J	58.2	J	62.8	J	137	J

Qualifiers:

B - value is greater than the Instrument Detection Limit but less than the Contract Required Detection Limit

J - estimated value

R - result is rejected and unusable

U - not detected

TABLE 4-3 (CONTINUED)
INORGANIC CHEMICALS DETECTED IN THE SOIL AND SEDIMENT
SITE 1 - NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

SAMPLE ID	01 SS 108	01 SS 109	01SS110C Background	01SS110D Background	01SS110E Background	01SED 111
UNITS	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg
Aluminum	11400	17200	19500	16400	18200	6390
Antimony	29.7 J	R	R	R	R	R
Arsenic	0.69 UJ	0.67 U	0.64 U	0.64 U	0.78 U	0.67 U
Barium	49.5	66.8	139	45.4	89.9	48.7
Beryllium	0.4 B	0.49 B	0.79 B	0.21 B	0.89 B	0.31 B
Cadmium	1.1 B	1.6	1.7	0.79 B	2	0.66 B
Calcium	3940	6420	7190	6130	6500	2310
Chromium	43.4	58.9	6.1	63.4	20.8	24.9
Cobalt	15	20.6	17.5	19.3	15.7	17.1
Copper	30.4 J	49.3 J	75.1 J	114 J	66.6 J	25.4 J
Iron	24800	50800	47100	20400	47700	19900
Lead	2.1	1.5	0.55 J	0.38 U	0.47 U	2.4
Magnesium	6670	8860	12200	15200	10500	5570
Manganese	658	554	839	298	675	795
Nickel	16.1	24.7	11.1	62.4	11.1	12.3
Potassium	778	686	1990	692	382	799
Selenium	0.56 UJ	0.53 UJ	0.51 UJ	0.51 UJ	0.63 UJ	0.54 UJ
Silver	1.9 J	2.3 J	1.3 UJ	2.7 J	1.6 UJ	1.4 UJ
Sodium	639 B	1110	1180	631 B	1120 B	395 B
Vanadium	83.3 J	138 J	131 J	38.4 J	146 J	63.5 J
Zinc	72.9 J	41.6 J	71.7 J	20.2 J	55.9 J	29.2 J

Qualifiers:

B - value is greater than the Instrument Detection Limit but less than the Contract Required Detection Limit

J - estimated value

R - result is rejected and unusable

U - not detected

Soil

VOC (acetone, carbon disulfide and toluene in low concentrations) were found in all samples but one from the landfill area. SVOC data are unreliable, but do not indicate significantly high concentrations. P/PCB were found at the landfill in one sample at a low concentration; the background location had trace to low concentrations. Inorganic cations of the TAL are in the range expectable for soils developed from a ferromanganous, igneous rock.

Sediments/terrestrial

The sediment sample was taken from the dry streambed below the landfill. VOC was found as a moderate concentration of acetone. SVOC data are unreliable, but do not indicate significantly high concentrations. P/PCBs were not found. Inorganic cations of the TAL are in the range expectable for soils developed from a ferromanganous, igneous rock.

4.3.2 Site 2 - Mangrove Disposal Site, Vieques Island

Tables 4-4 and 4-5 summarize the quantified values of compounds detected in the samples of Site 2 from the Supplemental Investigation. These values indicate the conditions that are described in the following sections.

Disposal Material

One sample, with its duplicate, of asphaltic oil was taken from a depression at Site 2. VOC were found in low (2-butanone and carbon disulfide), moderate (acetone) and high (methylene chloride) concentrations. SVOC data are unreliable, but do not indicate significantly high concentrations. P/PCB were found in trace to low concentrations. Inorganic cations of the TAL are in the range expectable for the shoreline deposits developed from a ferromanganous, igneous rock within which the asphaltic oil had been trapped.

Soil

VOC were found in trace to moderate concentrations (acetone, 2-butanone, carbon disulfide and methylene chloride) in all samples from the disposal area. SVOC data are unreliable, but do not indicate significantly high concentrations. P/PCB were found in trace to low

TABLE 4-4

ORGANIC COMPOUNDS DETECTED IN THE SOIL, SEDIMENT AND TAR

SITE 2 - NAVAL STATION ROOSEVELT ROADS

PUERTO RICO

SAMPLE ID	02 SS 112	02 SS 113	02 SS 114	02 SS 115	02 SS 116	02 SS 117	02 SS 118DUP (02 SS 113)	02 SED 122
UNITS	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg
VOLATILES								
Acetone	110 U	280 U	220 U	160 U	39 U	47 U	58 UJ	2000 J
Butanone,2-	13 U	14 U	13 U	15 U	13 UJ	14 UJ	14 UJ	25 U
Carbon disulfide	6 U	7 U	6 U	6 J	7 U	7 U	5 J	70
Methylene chloride	8 U	21 U	27 U	18 U	36 U	43 U	27 U	1000 J
PESTICIDES/PCBs								
Chlordane,alpha-	3 J	0.3 UJ	0.26 UJ	0.31 UJ	0.27 UJ	0.29 UJ	0.28 UJ	0.53 UJ
Chlordane,gamma-	3.5 J	0.3 UJ	0.26 UJ	0.31 UJ	0.27 UJ	0.29 UJ	0.28 UJ	0.53 UJ
DDD,4,4-	0.52 UJ	0.58 UJ	0.48 J	0.59 UJ	0.53 UJ	0.56 UJ	0.55 UJ	12 J
DDE,4,4-	2.5 J	0.58 UJ	1.9 NJ	0.59 UJ	2.8 J	0.76 J	0.55 UJ	22 J
DDT,4,4-	0.89 UJ	0.58 UJ	0.5 UJ	0.59 UJ	7.4 J	0.56 UJ	0.55 UJ	4 NJ
Dieldrin	0.52 UJ	0.58 UJ	9.3 J	0.59 UJ	0.53 UJ	0.56 UJ	0.55 UJ	1 UJ
Endrin aldehyde	0.52 UJ	0.58 UJ	0.5 UJ	0.59 UJ	0.53 UJ	0.56 UJ	0.55 UJ	1 UJ
Heptachlor	0.27 UJ	0.3 UJ	0.26 UJ	0.31 UJ	0.27 UJ	0.29 UJ	0.28 UJ	4.8 J
SEMIVOLATILES								
Benzo(a)anthracene	1600 U	1900 U	1700 U	1900 U	1700 U	1800 U	1800 U	3400 U
Benzo(b)fluoranthene	1600 U	1900 U	1700 U	1900 U	1700 U	1800 U	1800 U	3400 U
Bis(2-ethylhexyl)phthalate	1600 U	230 J	310 J	260 J	220 J	380 J	460 J	3400 U
Chrysene	1600 U	1900 U	1700 U	1900 U	1700 U	1800 U	1800 U	3400 U
Di-n-octylphthalate	1600 U	1900 U	1700 U	1900 U	1700 U	1800 U	1800 U	4200
Fluoranthene	1600 U	1900 U	1700 U	1900 U	1700 U	1800 U	1800 U	3400 U
Pyrene	1600 U	1900 U	1700 U	1900 U	1700 U	1800 U	1800 U	3400 U

QUALIFIERS:

D - parameter identified in an analysis at a secondary dilution factor

E - concentration exceeds calibration range of GC/MS instrument

J - estimated value

NA - not analyzed

NJ - presumptive evidence for the presence of the parameter at an estimated value

U - not detected

UJ - reported quantitation limit is estimated

TABLE 4-4 (CONTINUED)

ORGANIC COMPOUNDS DETECTED IN THE SOIL, SEDIMENT AND TAR

SITE 2 - NAVAL STATION ROOSEVELT ROADS

PUERTO RICO

SAMPLE ID	02 SED 123	02 SED 124	02 TAR 120	02 TAR 121DUP (02 TAR 120)	02 SS 119C Background	02 SS 119D Background	02 SS 119E Background
UNITS	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg
VOLATILES							
Acetone	510 J	820 E	390 J	1400 J	NA	NA	NA
Butanone,2-	13 U	15 U	26 U	110	NA	NA	NA
Carbon disulfide	6 U	8 U	20 UJ	13 UJ	NA	NA	NA
Methylene chloride	63 U	100 U	21000 D	4800 J	NA	NA	NA
PESTICIDES/PCBs							
Chlordane,alpha-	0.27 UJ	0.32 UJ	0.54 UJ	0.54 UJ	0.27 UJ	0.26 UJ	0.28 UJ
Chlordane,gamma-	0.27 UJ	0.32 UJ	0.54 UJ	0.99 J	0.27 UJ	0.26 UJ	0.28 UJ
DDD,4,4-	3.3 NJ	0.63 UJ	1.1 UJ	2 NJ	0.53 UJ	0.5 UJ	0.55 UJ
DDE,4,4-	7.3 J	1.5 NJ	1.6 J	5.8 J	0.53 UJ	0.5 UJ	0.55 UJ
DDT,4,4-	3.4 NJ	0.63 UJ	1.1 UJ	11 NJ	0.53 UJ	0.5 UJ	0.55 UJ
Dieldrin	0.52 UJ	0.63 UJ	1.1 UJ	1 UJ	0.53 UJ	0.5 UJ	0.55 UJ
Endrin aldehyde	0.52 UJ	7.7 J	1.1 UJ	1 UJ	0.53 UJ	0.5 UJ	0.55 UJ
Heptachlor	0.27 UJ	0.32 UJ	0.54 UJ	0.54 UJ	0.27 UJ	0.26 UJ	0.28 UJ
SEMIVOLATILES							
Benzo(a)anthracene	1500 U	1900 U	260 J	3200 U	NA	NA	NA
Benzo(b)fluoranthene	1500 U	1900 U	460 J	3200 U	NA	NA	NA
Bis(2-ethylhexyl)phthalate	1500 U	1900 U	3300 U	3200 U	NA	NA	NA
Chrysene	1500 U	1900 U	280 J	3200 U	NA	NA	NA
Di-n-octylphthalate	1500 U	1900 U	3300 U	3200 U	NA	NA	NA
Fluoranthene	1500 U	1900 U	420 J	3200 U	NA	NA	NA
Pyrene	1500 U	1900 U	340 J	3200 U	NA	NA	NA

QUALIFIERS:

D - parameter identified in an analysis at a secondary dilution factor

E - concentration exceeds calibration range of GC/MS instrument

J - estimated value

NA - not analyzed

NJ - presumptive evidence for the presence of the parameter at an estimated value

U - not detected

UJ - reported quantitation limit is estimated

TABLE 4-5
INORGANIC CHEMICALS DETECTED IN THE SOIL, SEDIMENT AND TAR
SITE 2 - NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

SAMPLE ID	02 SS 112	02 SS 113	02 SS 114	02 SS 115	02 SS 116	02 SS 117	02 SS 118DUP (02 SS 113)	02 SED 122
UNITS	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg
INORGANICS								
Aluminum	1490	941	1380	929	2800	4040	2510	6910
Arsenic	0.75 U	1.7 B	2 J	1.5 J	1.1 J	1.3 J	2.2 B	7.9 J
Barium	8.8 U	10.2 U	8.9 U	10.3 U	14.1	14.4 B	13.9 U	17.8 U
Beryllium	0.15 U	0.17 U	0.15 U	0.18 U	0.16 U	0.24 B	0.24 U	0.3 U
Cadmium	0.7 U	0.81 U	0.71 U	0.82 U	0.74 U	1.5 UJ	2.2 UJ	2.8 UJ
Calcium	168000	204000	115000	142000	103000	96500	257000	43600
Chromium	4.4	4.2	5.2	4	9.9	19.4	5	12.4
Cobalt	2.4 U	2.8 U	2.4 U	2.8 U	2.5 U	3.3 B	3.8 U	5.8 B
Copper	3.9 J	1.5 J	6.8 J	1.5 UJ	6.5 J	4.7 B	5 U	23.7
Iron	2830	3060	6080	2960	5550	5890 J	3460 J	22500 J
Lead	4.8	0.52 U	9.8	0.53 UJ	1.7 J	2.4 J	1.6 J	50.1
Magnesium	3110	3160	2440	2030	3350	3900	4470	8510
Manganese	88.2	49.4	121	69.6	277	218	86	339
Nickel	4.7 U	5.4 U	4.7 U	5.5 U	7.8 B	7.3	7.4 U	9.4 U
Potassium	652	533	731	749	426	822 J	1140 J	3500 J
Silver	1.6 UJ	1.8 UJ	1.6 UJ	1.8 UJ	1.7 UJ	1.8 U	2.5 U	3.2 U
Sodium	6140	8980	9460	10600	2560	3380 J	9500 J	19500 J
Thallium	0.38 UJ	0.44 UJ	0.38 UJ	0.44 UJ	0.39 UJ	0.42 U	0.59 UJ	0.76 UJ
Vanadium	8.9 J	9.9 J	10.3 J	12.5 J	14 J	21.5	19.4	35.9
Zinc	10.9 J	3.9 J	18.2 J	3.5 UJ	13.7 J	15.4	5.4 B	108

QUALIFIERS:

B - value is greater than the Instrument Detection Limit but less than the Contract Required Detection Limit

J - estimated value

R - result is rejected and unusable

U - not detected

UJ - reported quantitation limit is estimated

TABLE 4-5 (CONTINUED)
INORGANIC CHEMICALS DETECTED IN THE SOIL, SEDIMENT AND TAR
SITE 2 - NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

SAMPLE ID	02 SED 123	02 SED 124	02 TAR 120	02 TAR 121DUP (02 TAR 120)	02 SS 119C Background	02 SS 119D Background	02 SS 119E Background
UNITS	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg
INORGANICS							
Aluminum	5200	3340	9760	13500	1730	1610	1730
Arsenic	2.2 B	1.1 J	25.4	12.8	1.3 B	2 B	1.3 J
Barium	9.1 U	10.9 U	21.7 B	28.8 B	9.5 B	8.8 U	9.6 U
Beryllium	0.16 U	0.19 U	0.31 U	0.31 U	0.16 U	0.15 U	0.16 U
Cadmium	1.4 UJ	1.7 UJ	15.3	15.7	1.4 UJ	1.4 UJ	1.5 UJ
Calcium	29500	1740	50900	37000	83200	111000	128000
Chromium	16.3	4.8	53.9	59.1	3.4	5.7	4
Cobalt	5.1 B	4.5 B	4.9 U	12.6 B	2.5 U	2.4 U	2.6 U
Copper	19	9.8	215	243	3.3 U	3.2 U	3.5 U
Iron	9710 J	5390 J	127000 J	82100 J	4490 J	2710 J	2430 J
Lead	7	4.5	825 J	649	3.8	0.45 J	0.68 J
Magnesium	6530	3250	13600	13600	3270	3830	4440
Manganese	164	62.4	434	336	140	75.8	92.7
Nickel	7.9 B	5.8 U	22.4	23.6	4.9 U	4.7 U	5.1 U
Potassium	982 J	1750 J	2840 J	3490 J	837 J	774 J	991 J
Silver	1.8 B	2 B	5.2	3.5 B	2 B	1.6 U	2.2 B
Sodium	6070 J	8250 J	23000 J	25000 J	5510 J	6820 J	8460 J
Thallium	1 J	0.46 UJ	0.77 UJ	0.78 UJ	0.39 UJ	0.38 UJ	0.41 UJ
Vanadium	20.1	20.6	42.4	53.9	16.3	15.2	8.3 U
Zinc	30.5	110	1930	1860	6.3	2.4 U	3.9 B

QUALIFIERS:

B - value is greater than the Instrument Detection Limit but less than the Contract Required Detection Limit

J - estimated value

R - result is rejected and unusable

U - not detected

UJ - reported quantitation limit is estimated

concentrations. Inorganic cations of the TAL are in the range expectable for shoreline deposits developed from a ferromanganous, igneous rock.

Sediments/marine

VOC were found in trace to high concentrations (acetone, carbon disulfide and methylene chloride) in all samples from the disposal area; the highest concentrations (acetone and methylene chloride) were found in the sample from the station north of the disposal area, in the lagoon between the disposal area and the ocean. SVOC data are unreliable, but do not indicate significantly high concentrations. P/PCB were found in trace to low concentrations. Inorganic cations of the TAL are in the range expectable for shoreline deposits developed from a ferromanganous, igneous rock.

4.3.3 Site 5 - Army Cremator Disposal Area

Tables 4-6 and 4-7 summarize the quantified values of compounds detected in the samples of Site 5 from the Supplemental Investigation. Detections in specific media are described in the following sections.

Groundwater

VOC were not detected. SVOC data are unreliable, but do not indicate significantly high concentrations. P/PCB were found as a trace concentration of heptachlor. Inorganic cations of the TAL in the dissolved fraction (the part of the sample relevant to groundwater transport and to consumption of groundwater) are in the range expectable for groundwaters occupying shoreline deposits developed from a ferromanganous, igneous rock.

Soil

VOC were found in trace to moderate concentrations (acetone, carbon disulfide and methylene chloride) in all samples from the disposal area; the highest concentrations (station 05SS104 with samples 05SS133 and 05SS134) were found near the disposal trenches identified in the aerial photographs, by the geophysical survey and by inspection of the ground. SVOC data are unreliable, but do not indicate significantly high concentrations. P/PCB were found in trace to high concentrations; the highest concentration (4,4'-DDT) was found at one station (05SS103 with samples 05SS130 and 05SS131) sited in a disposal trench. Inorganic cations of the TAL

TABLE 4-6 (CONTINUED)
ORGANIC COMPOUNDS DETECTED IN THE GROUNDWATER AND SOIL
SITE 5 - NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

SAMPLE ID	05 SS 138	05 SS 139	05 SS 142	05 SS 143	05 SS 140C	05 SS 140D	05 SS140E
					Background	Background	Background
UNITS	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg
VOLATILES							
Acetone	83 J	12 UJ	NA	NA	NA	NA	NA
Carbon disulfide	6 U	6 U	NA	NA	NA	NA	NA
Methylene chloride	6 U	6 U	NA	NA	NA	NA	NA
PESTICIDES/PCBs							
BHC,beta-	1.9 UJ	2 U	1.1 J	2.2 U	1.9 U	1.8 U	1.8 U
BHC,delta-	1.9 U	2 UJ	0.86 J	2.2 U	1.9 U	1.8 U	1.8 U
BHC,gamma-	1.9 UJ	2 U	0.13 NJ	2.2 U	1.9 UJ	1.8 UJ	1.8 UJ
Chlordane,gamma-	1.9 U	2 U	4.2 J	2.2 U	1.9 UJ	1.8 U	0.24 J
DDD,4,4-	3.7 U	3.8 U	8.2 U	0.75 NJ	3.6 U	3.5 U	3.6 U
DDE,4,4-	3.7 U	3.8 UJ	8.2 U	4.3 U	3.6 UJ	3.5 UJ	3.6 U
DDT,4,4-	0.11 NJ	3.8 U	8.2 U	4.3 U	0.2 J	0.16 J	3.6 U
Dieldrin	3.7 UJ	3.8 UJ	4.2 UJ	2 J	3.6 U	3.5 U	3.6 U
Endosulfan I	1.9 UJ	2 UJ	1.5 NJ	2.8 NJ	1.9 UJ	1.8 UJ	1.8 UJ
Endrin	3.7 U	3.8 U	8.2 UJ	4.3 U	0.12 J	3.5 U	3.6 U
Endrin aldehyde	3.7 U	3.8 U	8.2 U	4.3 U	3.6 U	0.14 J	3.6 U
Heptachlor	1.9 UJ	2 U	0.42 J	2.2 U	1.9 U	1.8 U	1.8 UJ
Heptachlor epoxide	1.9 U	2 U	4.2 UJ	0.46 NJ	1.9 UJ	1.8 U	1.8 U
Methoxychlor	19 UJ	20 UJ	1.5 J	22 UJ	19 U	1.9 UJ	0.23 NJ
SEMIVOLATILES							
Bis(2-ethylhexyl)phthalate	1500 U	420 J	NA	NA	NA	NA	NA

Qualifiers:

C - results were confirmed by GC/MS

D - parameter identified in an analysis at a secondary dilution factor

J - estimated value

NA - not analyzed

NA* - No Action, sample result for the contaminant is not qualified with any blank qualifiers

NJ - presumptive evidence for the presence of the parameter at an estimated value

U - not detected

UJ - reported quantitation limit is estimated

TABLE 4-6
ORGANIC COMPOUNDS DETECTED IN THE GROUNDWATER AND SOIL
SITE 5 - NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

SAMPLE ID	05 GW 101A	05 GW 101B	05 SS 126	05 SS 127	05 SS 128	05 SS 129	05 SS 130
UNITS	ug/L	ug/L	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg
VOLATILES							
Acetone	NA	NA	73 J	160 J	170 UJ	12 U	38 J
Carbon disulfide	NA	NA	14	21	10	10	18
Methylene chloride	NA	NA	31 U	19 U	35 U	51 NA	28 U
PESTICIDES/PCBs							
BHC,beta-	0.05 U	NA	2 U	1.9 U	2 U	2.1 U	21 U
BHC,delta-	0.05 U	NA	0.097 U	1.9 U	2 UJ	0.19 J	21 UJ
BHC,gamma-	0.05 U	NA	2 U	1.9 U	2 U	2.1 U	21 U
Chlordane,gamma-	0.05 U	NA	2 U	1.9 U	2 UJ	2.1 UJ	21 U
DDD,4,4-	0.1 U	NA	1.8 J	3.7 U	0.26 J	4.1 U	180 NJ
DDE,4,4-	0.1 U	NA	5.5	0.49 J	2.2 J	1.2 J	480 J
DDT,4,4-	0.1 U	NA	2.1 J	0.31 NJ	2.9 J	2.6 J	3500 CD
Dieldrin	0.1 UJ	NA	3.8 UJ	3.7 U	3.9 U	4.1 U	40 U
Endosulfan I	0.05 U	NA	2 U	1.9 U	2 U	2.1 U	21 U
Endrin	0.1 U	NA	0.12 NJ	3.7 U	3.9 U	0.39 J	40 U
Endrin aldehyde	0.1 U	NA	3.8 U	3.7 U	3.9 U	4.1 U	40 U
Heptachlor	0.0032 J	NA	2 UJ	1.9 UJ	2 UJ	2.1 UJ	21 U
Heptachlor epoxide	0.05 U	NA	2 U	1.9 U	2 U	2.1 U	21 U
Methoxychlor	0.5 UJ	NA	0.44 NJ	19 U	21 UJ	21 U	210 U
SEMIVOLATILES							
Bis(2-ethylhexyl)phthalate	3 J	NA	1500 U	1500 U	1500 U	1500 U	430 J

Qualifiers:

C - results were confirmed by GC/MS

D - parameter identified in an analysis at a secondary dilution factor

J - estimated value

NA - not analyzed

NA* - No Action, sample result for the contaminant is not qualified with any blank qualifiers

NJ - presumptive evidence for the presence of the parameter at an estimated value

U - not detected

UJ - reported quantitation limit is estimated

TABLE 4-6 (CONTINUED)

ORGANIC COMPOUNDS DETECTED IN THE GROUNDWATER AND SOIL

SITE 5 - NAVAL STATION ROOSEVELT ROADS

PUERTO RICO

SAMPLE ID	05 SS 138	05 SS 139	05 SS 142	05 SS 143	05 SS 140C Background	05 SS 140D Background	05 SS140E Background
UNITS	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg
VOLATILES							
Acetone	83 J	12 UJ	NA	NA	NA	NA	NA
Carbon disulfide	6 U	6 U	NA	NA	NA	NA	NA
Methylene chloride	6 U	6 U	NA	NA	NA	NA	NA
PESTICIDES/PCBs							
BHC,beta-	1.9 UJ	2 U	1.1 J	2.2 U	1.9 U	1.8 U	1.8 U
BHC,delta-	1.9 U	2 UJ	0.86 J	2.2 U	1.9 U	1.8 U	1.8 U
BHC,gamma-	1.9 UJ	2 U	0.13 NJ	2.2 U	1.9 UJ	1.8 UJ	1.8 UJ
Chlordane,gamma-	1.9 U	2 U	4.2 J	2.2 U	1.9 UJ	1.8 U	0.24 J
DDD,4,4-	3.7 U	3.8 U	8.2 U	0.75 NJ	3.6 U	3.5 U	3.6 U
DDE,4,4-	3.7 U	3.8 UJ	8.2 U	4.3 U	3.6 UJ	3.5 UJ	3.6 U
DDT,4,4-	0.11 NJ	3.8 U	8.2 U	4.3 U	0.2 J	0.16 J	3.6 U
Dieldrin	3.7 UJ	3.8 UJ	4.2 UJ	2 J	3.6 U	3.5 U	3.6 U
Endosulfan I	1.9 UJ	2 UJ	1.5 NJ	2.8 NJ	1.9 UJ	1.8 UJ	1.8 UJ
Endrin	3.7 U	3.8 U	8.2 UJ	4.3 U	0.12 J	3.5 U	3.6 U
Endrin aldehyde	3.7 U	3.8 U	8.2 U	4.3 U	3.6 U	0.14 J	3.6 U
Heptachlor	1.9 UJ	2 U	0.42 J	2.2 U	1.9 U	1.8 U	1.8 UJ
Heptachlor epoxide	1.9 U	2 U	4.2 UJ	0.46 NJ	1.9 UJ	1.8 U	1.8 U
Methoxychlor	19 UJ	20 UJ	1.5 J	22 UJ	19 U	1.9 UJ	0.23 NJ
SEMIVOLATILES							
Bis(2-ethylhexyl)phthalate	1500 U	420 J	NA	NA	NA	NA	NA

Qualifiers:

C - results were confirmed by GC/MS

D - parameter identified in an analysis at a secondary dilution factor

J - estimated value

NA - not analyzed

NA* - No Action, sample result for the contaminant is not qualified with any blank qualifiers

NJ - presumptive evidence for the presence of the parameter at an estimated value

U - not detected

UJ - reported quantitation limit is estimated

TABLE 4-7

INORGANIC CHEMICALS DETECTED IN THE GROUNDWATER AND SOIL

SITE 5 - NAVAL STATION ROOSEVELT ROADS

PUERTO RICO

SAMPLE ID	05 GW 101A	05 GW 101B	05 SS 126	05 SS 127	05 SS 128	05 SS 129	05 SS 130
UNITS	ug/L	ug/L	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg
INORGANICS							
Aluminum	598 J	79.9 U	17100	6240	18200	40700	22600
Antimony	47.2 U	47.2 U	11.1 U	10.6 U	11.5 U	11 U	11.2 U
Barium	164 B	155 B	180	144	143	166	174
Beryllium	0.6 U	0.6 U	0.73 B	0.2 B	1.2	0.86 B	1.2
Cadmium	2.8 U	2.8 U	1.3	0.63 U	1.4	1.7	1.7
Calcium	158000	145000	9110	5430	6030	12500	8360
Chromium	10.3 UJ	10.3 UJ	13.9 J	2.8 J	16.4 J	35.7 J	24.2 J
Cobalt	9.6 U	9.6 U	16	18.8	24.8	23.8	24.1
Copper	5.9 B	6.8 B	131 J	53.3 J	57.4 J	106 J	68.5 J
Iron	857 J	51.8 B	31700	8630	41500	48800	47900
Lead	1.8 U	1.8 U	39.6 *	5.9 *	9.1 *	4.6 *	18.1 *
Magnesium	150000	143000	4550	5510	3710	5730	3550
Manganese	162 J	97.7	381 J	620 J	1140 J	848 J	994 J
Nickel	18.7 U	18.7 U	9.3 B	4.2 U	4.6 U	13.3	10
Potassium	1220 U	1180 U	315 U	245 U	299 U	371 U	430 U
Selenium	2.4 UJ	4.8 U	0.56 UJ	0.54 UJ	0.59 UJ	0.56 UJ	0.57 UJ
Silver	6.3 U	6.3 U	1.7 B	1.7 B	1.5 U	1.5 U	1.5 U
Sodium	1040000 J	1030000 J	1220	750 B	1400	2810	1640
Thallium	1.5 UJ	16.5 J	0.35 UJ	0.34 U	0.37 U	0.35 U	0.36 U
Vanadium	41.7 B	20.3 B	112 J	39.1 J	210 J	223 J	239 J
Zinc	25.8	12.1 U	84.9	28.6	31.9	42.2	63.8

Qualifiers:

B - value is greater than the Instrument Detection Limit but less than the Contract Required Detection Limit

J - estimated value

NA - not analyzed

U - not detected

UJ - reported quantitation limit is estimated

* - duplicate analysis is greater than control limit

TABLE 4-7 (CONTINUED)
INORGANIC CHEMICALS DETECTED IN THE GROUNDWATER AND SOIL
SITE 5 - NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

SAMPLE ID	05 SS 131	05 SS 132	05 SS 133	05 SS 134DUP (05 SS 133)	05 SS 135	05 SS 136	05 SS 137DUP (05 SS 136)
UNITS	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg
INORGANICS							
Aluminum	6920	8220	12800	9430	38500	14000	32800
Antimony	11.4 U	11.9 U	12.1 U	12.1 U	5.9 J	3 J	3.2 J
Barium	123	143	114	195	131	385	366
Beryllium	0.84 B	0.69 B	0.96 B	0.72 B	1.3	0.9 B	1 B
Cadmium	0.72 B	0.71 U	0.9 B	0.72 U	4.6	2.4	4.2
Calcium	6320	10800	5660	11200	3420	2210	2750
Chromium	14.9 J	20.5 J	33.3 J	21.3 J	19.5	9.6	15.3
Cobalt	22.5	34.6	35.5	33.8	24.5	16.5	17.5
Copper	25.8 J	91.6 J	141 J	93.6 J	35.3	31.6	45.4
Iron	19400	13300	25900	17900	69900	38600	62200
Lead	4.7 *	2 *	3.1 *	25.4 *	2.1 J	2 J	1.9 J
Magnesium	3360	5600	6910	5340	5250	5350	6310
Manganese	876 J	776 J	971 J	1450 J	1170	508	407
Nickel	4.9 B	18.8	20.8	17.5	4.7 U	4.5 U	4.4 U
Potassium	316 U	462 U	606 U	569 U	742 B	580 B	633 B
Selenium	0.58 UJ	0.61 UJ	0.62 UJ	0.62 UJ	0.6 U	0.57 U	0.56 UJ
Silver	1.6 B	2.3 B	1.6 U	1.6 U	1.1 UJ	1.1 UJ	1.1 UJ
Sodium	730 B	3700	3010	2230	2440 J	4370 J	4830 J
Thallium	0.36 U	0.38 U	0.38 U	0.38 U	0.38 UJ	0.36 UJ	0.35 UJ
Vanadium	131 J	108 J	160 J	116 J	195	134	176
Zinc	20.2	31.6	44.7	68.8	44.2	28.5	37.3

Qualifiers:

B - value is greater than the Instrument Detection Limit but less than the Contract Required Detection Limit

J - estimated value

NA - not analyzed

U - not detected

UJ - reported quantitation limit is estimated

* - duplicate analysis is greater than control limit

TABLE 4-7 (CONTINUED)
INORGANIC CHEMICALS DETECTED IN THE GROUNDWATER AND SOIL
SITE 5 - NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

SAMPLE ID	05 SS 138	05 SS 139	05 SS 142	05 SS 143	05 SS 140C Background	05 SS 140D Background	05 SS140E Background
UNITS	mg/Kg	mg/Kg	ug/Kg	ug/Kg	mg/Kg	mg/Kg	mg/Kg
INORGANICS							
Aluminum	9180	17700	NA	NA	6880	8720	5770
Antimony	2.3 U	2.3 U	NA	NA	10.6 U	10.6 U	10.6 U
Barium	46.5	132	NA	NA	92.5	141	101
Beryllium	0.69 B	0.63 B	NA	NA	0.39 B	0.46 B	0.42 B
Cadmium	1.3 UJ	1.3 UJ	NA	NA	0.63 U	0.63 U	0.63 U
Calcium	2920	6000	NA	NA	4520	4730	3390
Chromium	13.5	51.7	NA	NA	9 J	8 J	5.8 J
Cobalt	16.6	16	NA	NA	15.6	19.3	15.8
Copper	19.9	33.4	NA	NA	19.6 J	28.8 J	16.1 J
Iron	19700	27200	NA	NA	10300	12700	9250
Lead	1.9 J	1.6 J	NA	NA	4.1 *	4.7 *	3.1 *
Magnesium	4720	10200	NA	NA	2930	2860	2470
Manganese	735	656	NA	NA	696 J	976 J	764 J
Nickel	4.3 U	10.8	NA	NA	4.2 U	4.2 U	5.2 B
Potassium	320 B	205 U	NA	NA	1020 B	923 B	1310
Selenium	0.55 UJ	0.55 UJ	NA	NA	0.54 UJ	0.6 J	0.54 UJ
Silver	1 UJ	1 UJ	NA	NA	1.9 B	1.4 U	2.4
Sodium	4840 J	6520 J	NA	NA	500 U	575 U	507 U
Thallium	0.34 UJ	0.34 UJ	NA	NA	0.34 U	0.34 U	0.34 UJ
Vanadium	84.5	80.7	NA	NA	43.4 J	49.4 J	44.4 J
Zinc	18.8	49.4	NA	NA	24.6	38.6	22.4

Qualifiers:

B - value is greater than the Instrument Detection Limit but less than the Contract Required Detection Limit

J - estimated value

NA - not analyzed

U - not detected

UJ - reported quantitation limit is estimated

* - duplicate analysis is greater than control limit

are in the range expectable for unconsolidated material developed from a ferromanganous, igneous rock.

4.3.4 Site 6 - Langley Drive Disposal Area

Table 4-8 and 4-9 summarize the quantified values of compounds detected in the samples of Site 6 from the Supplemental Investigation. Conditions in specific media are described in the following sections.

Groundwater

VOC were not detected. SVOC data are unreliable, but do not indicate significantly high concentrations. P/PCB were not found. Inorganic cations of the TAL in the dissolved fraction (the part of the sample relevant to groundwater transport and to consumption of groundwater) are in the range expectable for groundwaters occupying shoreline deposits developed from a ferromanganous, igneous rock.

Soil

VOC were found as acetone, benzene, 2-butanone, ethylbenzene, methylene chloride, toluene and (o-,m-,p-)xylene in trace to moderate concentrations; the highest concentrations were found in samples 06SS142 from station 06SS101, 06SS145 from station 06SS103, 06SS147 from station 06SS104, 06SS150 and 06SS151 from station 06SS105, and 06SS153 and 06SS154 from station 05SS106 (stations 06SS101, 103 and 105 are off the front slope of the disposal face; stations 06SS102, 104 and 106 are within the disposal area). SVOC data are unreliable, but do not indicate significantly high concentrations. P/PCB were found randomly in trace to low concentrations. Inorganic cations of the TAL are in the range expectable for unconsolidated material in a coastal margin developed from a ferromanganous, igneous rock.

4.3.5 Site 10 - Building 25 Storage Area

Table 4-10 and 4-11 summarize the quantified values of compounds detected in the samples of Site 10 from the Supplemental Investigation. Conditions in specific media are described in the following sections.

TABLE 4-8
ORGANIC COMPOUNDS DETECTED IN THE GROUNDWATER AND SOIL
SITE 6 - NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

SAMPLE ID	06 GW 101A	06 SS 141	06 SS 142	06 SS 143	06 SS 145	06 SS 146
UNITS	ug/L	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg
VOLATILES						
Acetone	10 U	16 UJ	R	180 J	370 J	39 J
Benzene	5 U	8 U	18 U	10 U	7 U	7 U
Butanone,2-	10 U	16 UJ	410 J	19 UJ	14 UJ	15 UJ
Carbon disulfide	5 U	17 U	110 U	10 U	7 U	7 U
Ethylbenzene	5 U	8 U	18 UJ	10 U	7 U	7 U
Methylene chloride	5 U	24	590	9 J	65	11
Toluene	5 U	8 U	14 J	10 U	7	7 U
Xylene, o-	NA	8 U	18 UJ	10 U	7 U	7 U
Xylenes, m-, p-	NA	8 U	18 UJ	10 U	7 U	7 U
PESTICIDES/PCBs						
Aldrin	0.05 U	2.5 U	4.2 U	2.2 U	2.3 U	0.35 J
BHC,alpha-	0.05 U	0.085 NJ	4.2 U	2.2 U	2.3 UJ	2.7 U
BHC,beta-	0.05 U	0.8 NJ	1.1 J	2.2 U	2.3 U	2.7 U
BHC,delta-	0.05 U	0.39 NJ	0.86 J	2.2 U	2.3 U	2.7 U
BHC,gamma-	0.05 U	2.5 U	0.13 NJ	2.2 U	1.2 NJ	2.7 U
Chlordane,alpha-	0.05 U	2.5 UJ	4.2 UJ	2.2 U	2.3 U	2.7 U
DDD,4,4-	0.1 U	5.1	8.2 U	0.75 NJ	4.5 UJ	5.2 U
DDE,4,4-	0.1 U	3 NJ	8.2 U	4.3 U	5.3 J	5.2 U
DDT,4,4-	0.1 U	1 NJ	8.2 U	4.3 U	1.1 J	5.2 U
Dieldrin	0.1 UJ	4.9 U	4.2 UJ	2 J	4.5 UJ	5.2 U
Endosulfan I	0.05 U	2.5 U	1.5 NJ	2.8 NJ	2.3 UJ	2.7 U
Endosulfan II	0.1 U	4.9 U	8.2 UJ	4.3 U	0.15 NJ	5.2 U
Endosulfan sulfate	0.1 U	1 NJ	8.2 UJ	4.3 U	4.5 U	5.2 U
Endrin	0.1 U	4.9 UJ	8.2 UJ	4.3 U	0.15 NJ	5.2 U
Endrin aldehyde	0.1 U	4.9 U	8.2 U	4.3 U	0.71 J	5.2 U
Endrin ketone	0.1 U	4.9 UJ	8.2 U	4.3 U	0.25 NJ	5.2 U
Heptachlor	0.0017 NJ	0.36 J	0.42 J	2.2 U	0.17 J	2.7 U
Heptachlor epoxide	0.05 U	2.5 UJ	4.2 UJ	0.46 NJ	2.3 UJ	2.7 U
Methoxychlor	0.05 UJ	25 U	1.5 J	22 UJ	24 UJ	27 U

Qualifiers:

J - estimated value

NJ - presumptive evidence for the presence of the parameter at an estimated value

U - not detected

UJ - reported quantitation limit is estimated

E - concentration exceeds calibration range of GC/MS instrument

TABLE 4-8 (CONTINUED)
ORGANIC COMPOUNDS DETECTED IN THE GROUNDWATER AND SOIL
SITE 6 - NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

SAMPLE ID	06 GW 101A	06 SS 141	06 SS 142	06 SS 143	06 SS 145	06 SS 146
UNITS	ug/L	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg
SEMIVOLATILES						
Anthracene	21 U	2000 U	4400 U	2500 U	1900 U	110 J
Benzo(a)anthracene	21 U	2000 U	4400 U	2500 U	1900 U	1000 J
Benzo(a)pyrene	21 U	2000 U	4400 U	2500 U	180 J	270 J
Benzo(b)fluoranthene	21 U	2000 U	4400 U	2500 U	180 J	1300 J
Benzo(g,h,i)perylene	21 U	2000 U	4400 U	2500 U	1900 U	350 J
Benzo(k)fluoranthene	21 U	2000 U	4400 U	2500 U	260 J	2000
Bis(2-ethylhexyl)phthalate	2 J	2000 U	15000	2500 U	1900 U	1700 U
Carbazole	21 U	2000 U	4400 U	2500 U	1900 U	92 J
Chrysene	21 U	2000 U	4400 U	2500 U	150 J	1400 J
Di-n-butylphthalate	21 U	2000 U	4400 U	2500 U	1900 U	94 J
Dibenzo(a,h)anthracene	21 U	2000 U	4400 U	2500 U	1900 U	450 J
Fluoranthene	21 U	2000 U	4400 U	2500 U	1900 U	3200
Indeno(1,2,3-cd)pyrene	21 U	2000 U	4400 U	2500 U	1900 U	700 J
Phenanthrene	21 U	2000 U	4400 U	2500 U	1900 U	1900
Pyrene	21 U	2000 U	4400 U	2500 U	1900 U	2100

Qualifiers:
J - estimated value
NJ - presumptive evidence for the presence of the parameter at an estimated value
U - not detected
UJ - reported quantitation limit is estimated
E - concentration exceeds calibration range of GC/MS instrument
R - result is rejected and unusable

TABLE 4-8 (CONTINUED)
ORGANIC COMPOUNDS DETECTED IN THE GROUNDWATER AND SOIL
SITE 6 - NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

SAMPLE ID	06 SS 147	06 SS 148	06 SS 149DUP (06 SS 148)	06 SS 150	06 SS 151	06 SS 152DUP (06 SS 151)
UNITS	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg
VOLATILES						
Acetone	370 J	99 J	62 J	560 J	450 J	NA
Benzene	6 U	6 U	6 U	10 U	7 U	NA
Butanone,2-	12 UJ	12 UJ	12 UJ	20 UJ	14 UJ	NA
Carbon disulfide	3 J	6 U	6 U	10 U	7 U	NA
Ethylbenzene	6 U	6 U	6 U	10 U	7 U	NA
Methylene chloride	39 U	23	15	40	27	NA
Toluene	6 U	6 U	6 U	10 U	7 U	NA
Xylene, o-	6 U	6 U	6 U	10 U	7 U	NA
Xylenes, m-, p-	6 U	6 U	6 U	10 U	7 U	NA
PESTICIDES/PCBs						
Aldrin	2.2 U	2.2 U	2.1 U	2.4 U	2.4 U	2.5 U
BHC,alpha-	2.2 U	2.2 U	2.1 U	2.4 U	2.4 U	2.5 U
BHC,beta-	2.2 U	2.2 U	0.48 J	2.4 U	2.4 UJ	0.43 NJ
BHC,delta-	2.2 U	2.2 U	2.1 U	2.4 U	2.4 U	2.5 U
BHC,gamma-	2.2 U	2.2 U	2.1 U	2.4 U	2.4 UJ	2.5 U
Chlordane,alpha-	2.2 UJ	2.2 U	2.1 U	2.4 UJ	2.4 U	2.5 U
DDD,4,4-	4.2 U	4.3 U	4 U	4.7 UJ	4.7 U	4.8 U
DDE,4,4-	4.2 U	4.3 U	4 U	4.7 U	0.68 J	4.8 U
DDT,4,4-	4.2 UJ	4.3 U	4 U	0.74 J	1.7 J	0.22 NJ
Dieldrin	4.2 U	4.3 U	4 U	4.7 U	0.064 NJ	0.44 J
Endosulfan I	2.2 U	2.2 U	2.1 U	2.4 U	2.4 UJ	2.5 U
Endosulfan II	4.2 U	4.3 U	4 U	4.7 U	0.33 J	4.8 U
Endosulfan sulfate	4.2 U	4.3 U	4 U	4.7 U	4.7 U	4.8 U
Endrin	4.2 U	4.3 U	4 U	4.7 U	4.7 U	0.31 J
Endrin aldehyde	4.2 U	4.3 U	4 U	4.7 U	4.7 U	4.8 U
Endrin ketone	4.2 U	4.3 U	4 U	4.7 U	4.7 U	4.8 U
Heptachlor	0.11 J	2.2 UJ	2.1 U	2.4 UJ	2.4 UJ	2.5 U
Heptachlor epoxide	2.2 U	2.2 U	2.1 U	2.4 U	2.4 U	2.5 U
Methoxychlor	22 U	22 U	21 U	24 U	25 UJ	25 U

Qualifiers:

J - estimated value

NJ - presumptive evidence for the presence of the parameter at an estimated value

U - not detected

UJ - reported quantitation limit is estimated

E - concentration exceeds calibration range of GC/MS instrument

TABLE 4-8 (CONTINUED)
ORGANIC COMPOUNDS DETECTED IN THE GROUNDWATER AND SOIL
SITE 6 - NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

SAMPLE ID	06 SS 147	06 SS 148	06 SS 149DUP (06 SS 148)	06 SS 150	06 SS 151	06 SS 152DUP (06 SS 151)
UNITS	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg
SEMIVOLATILES						
Anthracene	1500 U	1600 U	1600 U	2700 U	1800 U	NA
Benzo(a)anthracene	1500 U	1600 U	1600 U	2700 U	1800 U	NA
Benzo(a)pyrene	1500 U	1600 U	1600 U	2700 U	1800 U	NA
Benzo(b)fluoranthene	1500 U	1600 U	1600 U	2700 U	1800 U	NA
Benzo(g,h,i)perylene	1500 U	1600 U	1600 U	2700 U	1800 U	NA
Benzo(k)fluoranthene	1500 U	1600 U	1600 U	2700 U	1800 U	NA
Bis(2-ethylhexyl)phthalate	1500 U	1600 U	1600 U	2700 U	3300	NA
Carbazole	1500 U	1600 U	1600 U	2700 U	1800 U	NA
Chrysene	1500 U	1600 U	1600 U	2700 U	1800 U	NA
Di-n-butylphthalate	1500 U	1600 U	1600 U	2700 U	1800 U	NA
Dibenzo(a,h)anthracene	1500 U	1600 U	1600 U	2700 U	1800 U	NA
Fluoranthene	1500 U	1600 U	1600 U	2700 U	1800 U	NA
Indeno(1,2,3-cd)pyrene	1500 U	1600 U	1600 U	2700 U	1800 U	NA
Phenanthrene	1500 U	1600 U	1600 U	2700 U	1800 U	NA
Pyrene	1500 U	1600 U	1600 U	2700 U	1800 U	NA

Qualifiers:
J - estimated value
NJ - presumptive evidence for the presence of the parameter at an estimated value
U - not detected
UJ - reported quantitation limit is estimated
E - concentration exceeds calibration range of GC/MS instrument
R - result is rejected and unusable

TABLE 4-8 (CONTINUED)
ORGANIC COMPOUNDS DETECTED IN THE GROUNDWATER AND SOIL
SITE 6 - NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

SAMPLE ID	06 SS 153	06 SS 154	06 SS 155C Background	06 SS 155D Background	06 SS 155E Background
UNITS	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg
VOLATILES					
Acetone	220 J	350 EJ	NA	NA	NA
Benzene	7 U	1 J	NA	NA	NA
Butanone,2-	13 UJ	13 J	NA	NA	NA
Carbon disulfide	7 U	R	NA	NA	NA
Ethylbenzene	7 U	2 J	NA	NA	NA
Methylene chloride	32	300 EJ	NA	NA	NA
Toluene	7 U	18 J	NA	NA	NA
Xylene, o-	7 U	3 J	NA	NA	NA
Xylenes, m-, p-	7 U	5 J	NA	NA	NA
PESTICIDES/PCBs					
Aldrin	0.27 J	2.1 U	2.2 U	2.2 U	1.9 U
BHC,alpha-	2.1 U	2.1 U	2.2 U	2.2 U	1.9 U
BHC,beta-	2.1 U	2.1 U	2.2 U	2.2 U	1.9 U
BHC,delta-	2.1 U	2.1 U	2.2 U	2.2 U	1.9 U
BHC,gamma-	2.1 U	2.1 U	2.2 U	2.2 U	1.9 U
Chlordane,alpha-	2.1 U	1.5 NJ	2.2 UJ	2.2 U	1.9 UJ
DDD,4,4-	4 U	4.1 U	4.3 U	4.2 U	3.7 U
DDE,4,4-	4 U	4.1 U	4.3 U	4.2 U	0.8 J
DDT,4,4-	4 U	4.1 UJ	0.92 U	4.2 U	0.82 J
Dieldrin	4 U	4.1 U	4.3 U	4.2 U	3.7 U
Endosulfan I	2.1 U	2.1 U	2.2 UJ	2.2 U	1.9 U
Endosulfan II	4 U	4.1 U	4.3 UJ	4.2 U	3.7 U
Endosulfan sulfate	4 U	4.1 U	4.3 U	4.2 U	3.7 U
Endrin	4 U	1.6 J	0.11 J	4.2 U	3.7 U
Endrin aldehyde	4 U	4.1 U	4.3 U	4.2 U	3.7 U
Endrin ketone	4 U	4.1 U	4.3 U	4.2 U	3.7 U
Heptachlor	2.1 UJ	2.1 UJ	2.2 UJ	2.2 UJ	1.9 UJ
Heptachlor epoxide	2.1 U	0.35 J	0.13 NJ	2.2 U	1.9 U
Methoxychlor	21 U	21 U	22 U	22 U	19 U

Qualifiers:

J - estimated value

NJ - presumptive evidence for the presence of the parameter at an estimated value

U - not detected

UJ - reported quantitation limit is estimated

E - concentration exceeds calibration range of GC/MS instrument

TABLE 4-8 (CONTINUED)
ORGANIC COMPOUNDS DETECTED IN THE GROUNDWATER AND SOIL
SITE 6 - NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

SAMPLE ID	06 SS 153	06 SS 154	06 SS 155C Background	06 SS 155D Background	06 SS 155E Background
UNITS	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg
SEMIVOLATILES					
Anthracene	1700 U	1400 U	NA	NA	NA
Benzo(a)anthracene	1700 U	1400 U	NA	NA	NA
Benzo(a)pyrene	1700 U	1400 U	NA	NA	NA
Benzo(b)fluoranthene	1700 U	1400 U	NA	NA	NA
Benzo(g,h,i)perylene	1700 U	1400 U	NA	NA	NA
Benzo(k)fluoranthene	1700 U	1400 U	NA	NA	NA
Bis(2-ethylhexyl)phthalate	1700 U	630 J	NA	NA	NA
Carbazole	1700 U	1400 U	NA	NA	NA
Chrysene	1700 U	1400 U	NA	NA	NA
Di-n-butylphthalate	1700 U	1400 U	NA	NA	NA
Dibenzo(a,h)anthracene	1700 U	1400 U	NA	NA	NA
Fluoranthene	1700 U	1400 U	NA	NA	NA
Indeno(1,2,3-cd)pyrene	1700 U	1400 U	NA	NA	NA
Phenanthrene	1700 U	1400 U	NA	NA	NA
Pyrene	1700 U	1400 U	NA	NA	NA

Qualifiers:
J - estimated value
NJ - presumptive evidence for the presence of the parameter at an estimated value
U - not detected
UJ - reported quantitation limit is estimated
E - concentration exceeds calibration range of GC/MS instrument
R - result is rejected and unusable

TABLE 4-9
INORGANIC CHEMICALS DETECTED IN THE GROUNDWATER AND SOIL
SITE 6 - NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

SAMPLE ID	06 GW 101A	06 GW 101B	06 SS 141	06 SS 142	06 SS 143	06 SS 145
UNITS	ug/L	ug/L	mg/Kg	mg/Kg	mg/Kg	mg/Kg
INORGANICS						
Aluminum	1200	48.9 J	21600	12400	20000	15100
Antimony	47.2 U	47.2 U	17.9 J	21.4 J	6.3 J	20.1 J
Arsenic	3 U	3 U	17.5	21.4	1.2 U	19.6
Barium	22.5 U	35.2 U	156	25.1 U	100	410
Beryllium	1.5 B	0.6 U	0.47 B	0.82 B	0.51 B	0.77 B
Cadmium	2.8 U	2.8 U	8.7	9.3	2.1 UJ	3.9
Calcium	62500	58700	51900	15900	9920	48200
Chromium	10.4 UJ	10.4 UJ	59.8	110	19	40.6
Cobalt	15.5 UJ	15.5 UJ	10.7 B	6.9 U	23.7	16.8
Copper	5.1 UJ	8.5 J	5850	1490	227	739
Iron	1730	14.5 UJ	168000	238000	43400	38000
Lead	1.5 UJ	1.8 U	1210 J	546 J	130 J	4760 J
Magnesium	80700	77500	9980	14600	12200	10900
Manganese	R	R	972	766	808	596
Mercury	0.2 UJ	0.2 UJ	0.15 U	0.3 U	0.15 U	0.45
Nickel	7.8 UJ	7.8 UJ	49.9	108	10.2 B	19.4
Potassium	2180 U	2250 BU	1540 B	3690	2760	2350
Selenium	4.8 J	9.2 J	0.75 U	2.1 J	0.92 U	0.7 U
Sodium	801000 J	786000 J	13100 J	50100 J	13100 J	4940 J
Vanadium	30 J	17.9 J	90.6	145	118	122
Zinc	20.2 J	16.5 B	3350	592	200	1440

Qualifiers:

B - value is greater than the Instrument Detection Limit but less than the Contract Required Detection Limit

J - estimated value

NA - not analyzed

R - result is rejected and unusable

U - not detected

UJ - reported quantitation limit is estimated

TABLE 4-9 (CONTINUED)
INORGANIC CHEMICALS DETECTED IN THE GROUNDWATER AND SOIL
SITE 6 - NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

SAMPLE ID	06 SS 146	06 SS 147	06 SS 148	06 SS 149DUP (06 SS 148)	06 SS 150	06 SS 151
UNITS	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg
INORGANICS						
Aluminum	18600	1660 J	7220 J	13700 J	36600 J	38600 J
Antimony	19.8 J	2.4 UJ	2.4 UJ	2.4 UJ	4 UJ	2.8 UJ
Arsenic	18.7	3.3	0.95 B	1.7 B	1.2 U	1.5 J
Barium	509	24 B	32.4 B	41.9 B	189	213
Beryllium	0.57 B	0.15 U	0.16 B	0.22 B	1.5 B	1.3 B
Cadmium	5	1.3 UJ	1.3 UJ	1.3 UJ	6.3	5.1
Calcium	61000	487000	20100 B	337000	6460	10700
Chromium	39.4	6.1	15.4	21.7	13.5	2.8
Cobalt	15.7	2.3 U	3.5 B	4.9 B	45.5	14.1
Copper	774	4.3 B	13.2	17.6	136	86.3
Iron	44900	4040 J	9050 J	16000 J	107000 J	84100 J
Lead	5850 J	3.1	7.4	3.4	7.5	5
Magnesium	12700	3290	5890	8250	5450	10900
Manganese	601	75.5	212	458	1090	245
Mercury	0.68	0.12 U	0.1 U	0.09 U	0.16 U	0.13 U
Nickel	17.4	4.6 UJ	4.5 UJ	4.6 UJ	7.6 UJ	5.3 UJ
Potassium	2200	347 BU	549 BU	788 B	676 BU	1200 B
Selenium	0.72 J	0.59 UJ	0.58 UJ	0.59 UJ	0.98 UJ	0.68 UJ
Sodium	7540 J	2800 J	3830 J	5630 J	7830 J	11300 J
Vanadium	116	9.3 B	22.8	33.7	386	257
Zinc	2010	8.3	24.3	33.8	89.2	80.7

Qualifiers:

B - value is greater than the Instrument Detection Limit but less than the Contract Required Detection Limit

J - estimated value

NA - not analyzed

R - result is rejected and unusable

U - not detected

UJ - reported quantitation limit is estimated

TABLE 4-9 (CONTINUED)
INORGANIC CHEMICALS DETECTED IN THE GROUNDWATER AND SOIL
SITE 6 - NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

SAMPLE ID	06 SS 152 DUP (06 SS 151)	06 SS 153	06 SS 154	06 SS 155C Background	06 SS 155D Background	06 SS 155E Background
UNITS	ug/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg
INORGANICS						
Aluminum	NA	23900 J	22800 J	20600 J	27200 J	24100 J
Antimony	NA	2.6 UJ	2.9 J	3.8 J	3 J	2.8 J
Arsenic	NA	6.9	10.5	0.83 U	0.82 U	0.78 U
Barium	NA	263	173	78.2	83.1	129
Beryllium	NA	0.41 B	0.42 B	1.4	1.4	1.7
Cadmium	NA	1.5 UJ	1.5 UJ	3.3	3.9	2.7
Calcium	NA	166000	154000	2760	1880	16000
Chromium	NA	42.7	26.4	33	40.7	37.4
Cobalt	NA	11.5 B	14.2	40.1	41.1	82.3
Copper	NA	77.8	60.7	48.8	54.5	47.5
Iron	NA	20800 J	24400 J	53200 J	62700 J	63600 J
Lead	NA	77.4	89.5	3.8	5.6	8.6
Magnesium	NA	8600	9220	4690	4740	3960
Manganese	NA	842	615	1010	598	3130
Mercury	NA	0.12 U	0.13 U	0.12 U	0.13 U	0.12 U
Nickel	NA	12 J	5.1 UJ	5.2 UJ	5.1 UJ	14.3 J
Potassium	NA	2000	1880	331 BU	375 BU	363 BU
Selenium	NA	0.64 UJ	0.65 UJ	0.67 UJ	0.66 UJ	0.62 UJ
Sodium	NA	6900 J	7470 J	4150 J	5630 J	2810 J
Vanadium	NA	65.8	70.5	230	210	256
Zinc	NA	206	102	35.5	40.7	39.1

Qualifiers:

B - value is greater than the Instrument Detection Limit but less than the Contract Required Detection Limit

J - estimated value

NA - not analyzed

R - result is rejected and unusable

U - not detected

UJ - reported quantitation limit is estimated

TABLE 4-1υ
ORGANIC COMPOUNDS DETECTED IN THE SOIL
SITE 10 - NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

SAMPLE ID	10 SS 156	10 SS 158DUP (10 SS 156)	10 SS 159	10 SS 161	10 SS 163	10 SS 165C Background	10 SS 165D Background	10 SS 165E Background
UNITS	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg
VOLATILES								
Carbon disulfide	21 U	15 U	7 U	7 J	39 J	NA	NA	NA
Methylene chloride	27 U	32 U	29 U	20 U	98 J	NA	NA	NA
Toluene	6 U	6 U	5 U	6 UJ	3 J	NA	NA	NA
Xylene, m-, p-	6 U	6 U	5 U	6 UJ	2 J	NA	NA	NA
PESTICIDES\PCBs								
BHC,beta-	0.24 UJ	0.24 UJ	0.23 UJ	0.24 UJ	0.22 UJ	0.29 UJ	0.7 J	0.30 UJ
DDE,4,4-	0.46 UJ	0.47 UJ	0.45 UJ	3.7 J	0.43 UJ	0.56 UJ	2.9 J	0.93 J
DDT,4,4-	0.46 UJ	0.47 UJ	0.45 UJ	2.4 J	0.43 UJ	0.56 UJ	1.8 J	0.57 UJ
Endosulfan sulfate	0.46 UJ	0.47 UJ	0.54 J	0.46 UJ	0.43 UJ	0.56 UJ	0.52 UJ	0.57 UJ
Methoxychlor	2.4 UJ	2.4 UJ	2.3 UJ	1.5 UJ	2.2 UJ	2.9 UJ	3.8 J	0.59 UJ
SEMIVOLATILES								
Acenaphthene	1500 U	1500 U	84 J	1500 U	1300 U	NA	NA	NA
Anthracene	1500 U	1500 U	110 J	1500 U	1300 U	NA	NA	NA
Benzo(a)anthracene	1500 U	1500 U	510 J	460 J	360 J	NA	NA	NA
Benzo(a)pyrene	1500 U	1500 U	310 J	260 J	350 J	NA	NA	NA
Benzo(b)fluoranthene	1500 U	1500 U	620 J	790 J	830 J	NA	NA	NA
Benzo(g,h,i)perylene	1500 U	1500 U	150 J	200 J	1300 UJ	NA	NA	NA
Bis(2-chloroisopropyl)ether	1500 U	1500 U	450 J	1500 U	550 J	NA	NA	NA
Bis(2-ethylhexyl)phthalate	310 J	1500 U	250 J	160 J	130 J	NA	NA	NA
Chrysene	1500 U	1500 U	800 J	500 J	370 J	NA	NA	NA
Dibenzo(a,h)anthracene	1500 U	1500 U	1400 U	160 J	1300 UJ	NA	NA	NA
Fluoranthene	1500 U	1500 U	970 J	1100 J	530 J	NA	NA	NA
Indeno(1,2,3-cd)pyrene	1500 U	1500 U	270 J	340 J	1300 UJ	NA	NA	NA
Phenanthrene	1500 U	1500 U	490 J	470 J	310 J	NA	NA	NA
Pyrene	1500 U	1500 U	730 J	750 J	810 J	NA	NA	NA

Qualifiers:
J - estimated value
NA - not analyzed
R - rejected value
U - not detected
UJ - reported quantitation limit is estimated

TABLE 4-11
INORGANIC CHEMICALS DETECTED IN THE SOIL
SITE 10 - NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

SAMPLE ID	10 SS 156	10 SS 158DUP (10 SS 156)	10 SS 159	10 SS 161	10 SS 163	10 SS 165C Background	10 SS 165D Background	10 SS 165E Background
UNITS	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg
Aluminum	17500	20600	21100	18900	7560	11400	10100	9910
Arsenic	0.67	0.68 U	1.1 B	0.67 U	4.8 J	1.1 B	1.5 J	0.85 B
Barium	67.1	74.4	122	82.4	28.2 B	148	48 B	84.8
Beryllium	0.37 B	0.44 B	0.4 B	0.29 B	0.37 B	1.4	0.33 B	0.92 B
Cadmium	1.2 UJ	1.2 UJ	2.5	2.6	1.2 UJ	1.5 UJ	1.4 UJ	2
Calcium	10100	9460	40900	53100	191000	6450	89500	13800
Chromium	18.4	22.8	15.4	15	29.9	5.6	3	7
Cobalt	21.7	21.6	24.8	14.1	7.3 B	133	15.7	38.8
Copper	162	169	98.5	62.9	19.2	90.1	27.1 U	65.7
Iron	20700	21300 J	31500 J	29300 J	8860	37900 J	10600 J	24800 J
Lead	2.5	3.8	61.1	39.2	26.7	7.1	5.1	6.4
Magnesium	8020	8040	10200	8880	4620	2880	3870	2730
Manganese	694	654	954	545	200	5030	518	1970
Mercury	0.09 U	0.09 U	0.18	0.11 U	0.1 U	0.12 U	0.11 U	0.13 U
Nickel	16.4	17.1	12.8	9.4	6.8 B	7.6 B	5.8 B	5.2 U
Potassium	596	716 J	1930 J	2620 J	606 J	489 J	504 J	504 J
Selenium	0.54 U	0.54 U	0.52 U	0.53 U	0.52 UJ	1.3 B	0.61 UJ	0.71 J
Silver	1.4 U	1.9 B	2 B	1.4 U	1.8 B	1.7 U	1.6 U	2 B
Sodium	4300	4850 J	2390 J	1820 J	1700 J	2060 J	2080 J	1890 J
Vanadium	76.5	84.6	116	101	59.7	210	62.1	148
Zinc	112	118	202	136	49.2	48.9	22.1	39.9

Qualifiers:

B - value is greater than the Instrument Detection Limit but less than the Contract Required Detection Limit

J - estimated value

U - not detected

UJ - reported quantitation limit is estimated

Soil

VOC are largely absent from Site 10 samples; a trace concentration of carbon disulfide was found in one sample, and trace concentrations of toluene and (m-,p-)xylene with low concentrations of carbon disulfide and methylene chloride were found in another. SVOC data are unreliable, but do not indicate significantly high concentrations. P/PCB were found randomly in trace to low concentrations. Inorganic cations of the TAL are in the range expectable for unconsolidated, colluvial material developed from a ferromanganous, igneous rock.

4.3.6 Site 14 - Ensenada Honda Shoreline and Mangroves

Tables 4-12 and 4-13 summarize the quantified values of compounds detected in the samples of Site 14 from the Supplemental Investigation. Conditions in specific media are described in the following sections.

Sediments/marine

VOC compounds were found in trace to moderate concentrations of acetone, carbon disulfide, methylene chloride and toluene in all samples, including background. SVOC data are unreliable, but do not indicate significantly high concentrations. P/PCB were found randomly in trace to low concentrations. Inorganic cations of the TAL are in the range expectable for unconsolidated material in a coastal margin developed from a ferromanganous, igneous rock.

4.3.7 Site 18 - Building 128, Pest Control Shop and Surrounding Area

Table 4-14 and 4-15 summarize the quantified values of compounds detected in the samples of Site 18 from the Supplemental Investigation. Conditions in specific media are described in the following sections.

Groundwater

VOC were present as trace concentrations of acetone, carbon disulfide and tetrachloroethene. SVOC data are unreliable, but do not indicate significantly high concentrations. P/PCB were not found. Inorganic cations of the TAL in the dissolved fraction (the part of the sample relevant to groundwater transport and to consumption of groundwater) are in the range

TABLE 4-12

ORGANIC COMPOUNDS DETECTED IN THE SEDIMENT AND GROUNDWATER

SITE 14 - NAVAL STATION ROOSEVELT ROADS

PUERTO RICO

SAMPLE ID	14 GW 101	14 SED 166	14 SED 167	14 SED 168	14 SED 169	14 SED 170DUP (14 SED 169)	14 SED 171 Background
UNITS	ug/L	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg
VOLATILES							
Acetone	10 U	39 J	91 U	23 U	500 J	64 J	37 UJ
Carbon disulfide	5 U	17 U	66 U	35 U	5 J	13 U	37
Methylene chloride	5 U	15	190	29	28	75	15 J
Toluene	5 U	9 U	45 UJ	11 U	14 UJ	13 UJ	120
PESTICIDES/PCBs							
Aldrin	NA	3.2 U	0.91 J	3.2 U	0.61 J	0.22 NJ	8.4 U
BHC,alpha-	NA	3.2 U	9.9 U	0.39 J	4.3 U	0.071 J	8.4 U
Chlordane, alpha	NA	3.2 UJ	0.36 J	3.2 UJ	4.3 U	4.1 U	5.5 J
DDD,4,4-	NA	6.2 U	19 U	6.3 UJ	8.4 U	7.9 U	4.1 J
DDE,4,4-	NA	6.2 U	19 U	6.3 U	8.4 U	0.26 J	25
DDT,4,4-	NA	6.2 U	19 U	0.22 NJ	8.4 U	0.58 NJ	16 U
Endosulfan II	NA	6.2 U	19 U	6.3 U	8.4 U	0.21 NJ	16 U
Endrin aldehyde	NA	6.2 U	19 U	6.3 U	8.4 U	0.94 J	2.1 NJ
Heptachlor	NA	3.2 UJ	9.9 U	3.2 U	4.3 UJ	0.27 NJ	8.4 UJ
Heptachlor epoxide	NA	3.2 U	9.9 U	3.2 U	4.3 U	0.62 NJ	1.1 J
Methoxychlor	NA	32 U	99 U	32 U	43 U	41 U	3.1 NJ
SEMIVOLATILES							
Di-n-butylphthalate	NA	2300 U	12000 UJ	220 J	R	3300 U	4800 U

Qualifiers:

J - estimated value

R - result is rejected and unusable

U - not detected

UJ - reported quantitation limit is estimated

NJ - presumptive evidence for the presence of the material at an estimated value

TABLE 4-13
INORGANIC CHEMICALS DETECTED IN THE SEDIMENT
SITE 14 - NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

SAMPLE ID	14 SED 166	14 SED 167	14 SED 168	14 SED 169	14 SED 170DUP (14 SED 169)	14 SED 171 Background
UNIT	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg
Aluminum	5810	31300	10000	8350	1020	3540
Arsenic	5.8	10.8 B	6.6	5.8	4.4 B	2.2 U
Barium	16.2 B	64 U	16 U	19.6 U	17.6 U	26.1 U
Beryllium	0.22 U	1.2 B	0.27 U	0.33 U	0.3 U	0.44 U
Calcium	375000	31900	424000	686000	594000	153000
Chromium	15	32.8	21	3.5 B	5.5	14.6
Copper	12.8	66.7	9.2 B	7.1 U	6.4 U	9.4 U
Iron	9360	33700	9400	23800	27600	5450
Lead	3.8 J	8.3 J	1.7 J	2.4 J	2.5 J	2.7 J
Magnesium	12100	28400	150000	69500	6750	8230
Manganese	114	228	122	18.1	25.4	49.9
Nickel	6.8 U	36.9 B	8.5 U	10.4 U	9.4 U	13.9 U
Potassium	1350 B	8680 B	1620 B	1120 B	1020 B	2430 B
Selenium	0.87 UJ	4.4 U	2.6 J	1.3 UJ	1.2 UJ	1.8 UJ
Sodium	13800 J	121000 J	21200 J	20600 J	19000 J	48300 J
Vanadium	24.2	136	23.5	7.9 U	7.2 U	26.6 B
Zinc	14.8	112	17.1	5.4 B	10.1	10.2 B

Qualifiers:

J - estimated value

R - result is rejected and unusable

U - not detected

UJ - reported quantitation limit is estimated

B - value is greater than the Instrument Detection Limit but less than the Contract Required Detection Limit

TABLE 4-14

ORGANIC COMPOUNDS DETECTED IN THE GROUNDWATER, SOIL, SURFACE WATER AND SEDIMENT

SITE 18 - NAVAL STATION ROOSEVELT ROADS

PUERTO RICO

SAMPLE ID	18 GW 101	18 GW 102	18 GW 103	18 GW 169	18 SS 172	18 SS 173	18 SS 174
UNITS	ug/L	ug/L	ug/L	ug/L	ug/Kg	ug/Kg	ug/Kg
VOLATILES							
Acetone	15 J	19 J	13 J	10 U	17 U	17 U	230
Butanone,2-	10 U	10 U	10 U	10 U	R	R	R
Carbon disulfide	3 J	2 J	5 U	5 U	3 J	9 U	6 U
Tetrachloroethene	5 U	5 U	5 U	5 J	6 U	9 U	6 U
Toluene	5 U	5 U	5 U	5 U	6 U	9 U	6 U
PESTICIDES/PCBs							
Chlordane,alpha-	0.0064 U	0.0064 U	0.0064 U	NA	24 J	4.1 J	13 J
Chlordane,gamma-	0.0064 U	0.0064 U	0.0064 U	NA	23 J	3.7 J	14 UJ
DDD,4,4-	0.013 U	0.013 U	0.013 U	NA	140 J	38 J	160 J
DDE,4,4-	0.013 U	0.013 U	0.013 U	NA	380 J	53 J	150 J
DDT,4,4-	0.013 U	0.013 U	0.013 U	NA	1300 EJ	320 J	4500 EJ
Endosulfan I	0.0064 U	0.0064 U	0.0064 U	NA	4.6 UJ	3.6 UJ	14 UJ
SEMIVOLATILES							
Benzo(a)anthracene	20 UJ	21 U	20 U	NA	1500 U	3400 U	1600 U
Benzo(a)pyrene	20 UJ	21 U	20 U	NA	1500 U	3400 U	1600 U
Benzo(b)fluoranthene	20 UJ	21 U	20 U	NA	1500 U	3400 U	1600 U
Bis(2-ethylhexyl)phthalate	23 UJ	2 J	20 U	NA	460 J	1700 J	1600 U
Chrysene	20 UJ	21 U	20 U	NA	1500 U	3400 U	1600 U
Fluoranthene	20 UJ	21 U	20 U	NA	1500 U	3400 U	1600 U
Indeno(1,2,3-cd)pyrene	20 UJ	21 U	20 U	NA	1500 U	3400 U	1600 U
Pyrene	20 UJ	21 U	20 U	NA	1500 U	3400 U	1600 U

Qualifiers:

E - concentration exceeds calibration range of GC/MS instrument

J - estimated value

NA - not analyzed

R - result is rejected and unusable

U - not detected

UJ - reported quantitation limit is estimated

TABLE 4-14 (CONTINUED)

ORGANIC COMPOUNDS DETECTED IN THE GROUNDWATER, SOIL, SURFACE WATER AND SEDIMENT

SITE 18 - NAVAL STATION ROOSEVELT ROADS

PUERTO RICO

SAMPLE ID	18 SS 175	18 SS 176	18 SS 177	18 SS 178DUP (18 SS 177)	18 SS 179	18SS181C Background	18SS181D Background
UNITS	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg
VOLATILES							
Acetone	55 J	76 U	310 J	32 U	61 U	NA	NA
Butanone,2-	14 U	12 U	R	R	11 U	NA	NA
Carbon disulfide	8 U	6 U	6 U	3 J	6 U	NA	NA
Tetrachloroethene	7 U	6 U	6 U	6 U	6 U	NA	NA
Toluene	7 U	6 U	6 U	6 U	6 U	NA	NA
PESTICIDES/PCBs							
Chlordane,alpha-	2.6 UJ	0.24 UJ	0.24 UJ	0.23 UJ	5.2 J	0.22 UJ	0.22 UJ
Chlordane,gamma-	2.6 UJ	0.24 UJ	0.24 UJ	0.23 UJ	5 J	0.22 UJ	0.22 UJ
DDD,4,4-	5.1 J	0.47 UJ	0.47 UJ	0.71 J	11 J	0.42 UJ	0.42 UJ
DDE,4,4-	9.4 J	4.7 J	1.2 J	1.6 J	40 J	6.5 J	17 J
DDT,4,4-	120 J	3.4 J	1.1 J	1.2 J	36 J	4.2 J	6 J
Endosulfan I	2.6 UJ	0.24 UJ	0.24 UJ	0.23 UJ	0.23 UJ	0.22 UJ	0.22 UJ
SEMIVOLATILES							
Benzo(a)anthracene	1800 U	1600 U	1500 U	1600 U	310 J	NA	NA
Benzo(a)pyrene	1800 U	1600 U	1500 U	1600 U	350 J	NA	NA
Benzo(b)fluoranthene	1800 U	1600 U	1500 U	1600 U	660 J	NA	NA
Bis(2-ethylhexyl)phthalate	1100 J	600 J	350 J	1600 U	1500 U	NA	NA
Chrysene	1800 U	1600 U	1500 U	1600 U	450 J	NA	NA
Fluoranthene	1800 U	1600 U	1500 U	1600 U	240 J	NA	NA
Indeno(1,2,3-cd)pyrene	1800 U	1600 U	1500 U	1600 U	260 J	NA	NA
Pyrene	1800 U	1600 U	1500 U	1600 U	300 J	NA	NA

Qualifiers:

E - concentration exceeds calibration range of GC/MS instrument

J - estimated value

NA - not analyzed

R - result is rejected and unusable

U - not detected

UJ - reported quantitation limit is estimated

TABLE 4-14 (CONTINUED)

ORGANIC COMPOUNDS DETECTED IN THE GROUNDWATER, SOIL, SURFACE WATER AND SEDIMENT

SITE 18 - NAVAL STATION ROOSEVELT ROADS

PUERTO RICO

SAMPLE ID	18SS181E	18 SW 108	18 SED 182
	Background		
UNITS	ug/Kg	ug/L	ug/Kg
VOLATILES			
Acetone	NA	18	730
Butanone,2-	NA	10 U	390 J
Carbon disulfide	NA	5 U	19 U
Tetrachloroethene	NA	5 U	19 UJ
Toluene	NA	5 U	68 J
PESTICIDES/PCBs			
Chlordane,alpha-	0.23 UJ	0.017	160 J
Chlordane,gamma-	0.23 UJ	0.0066 U	180 J
DDD,4,4-	0.44 UJ	0.076	4700 EJ
DDE,4,4-	3.4 J	0.092	550 J
DDT,4,4-	3.7 J	0.013 U	490 J
Endosulfan I	0.23 UJ	0.0066 U	230 J
SEMIVOLATILES			
Benzo(a)anthracene	NA	23 U	5100 U
Benzo(a)pyrene	NA	23 U	5100 U
Benzo(b)fluoranthene	NA	23 U	5100 U
Bis(2-ethylhexyl)phthalate	NA	2 J	1100 J
Chrysene	NA	23 U	5100 U
Fluoranthene	NA	23 U	5100 U
Indeno(1,2,3-cd)pyrene	NA	23 U	5100 U
Pyrene	NA	23 U	5100 U

Qualifiers:

E - concentration exceeds calibration range of GC/MS instrument

J - estimated value

NA - not analyzed

R - result is rejected and unusable

U - not detected

UJ - reported quantitation limit is estimated

TABLE 4-15
INORGANIC CHEMICALS DETECTED IN THE GROUNDWATER, SOIL, SURFACE WATER AND SEDIMENT
SITE 18 - NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

SAMPLE ID	18 GW 101A	18 GW 101B	18 GW 102A	18 GW 102B	18 GW 103A	18 GW 103B	18 SS 172
UNITS	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	mg/Kg
Aluminum	518 J	39.2 UJ	3850	53 J	5550 J	39.2 UJ	24100 J
Arsenic	3 UJ	3 UJ	3.1 J	3 UJ	3 UJ	3 UJ	0.69 UJ
Barium	22.5 UJ	22.5 UJ	1120	1120	22.5 UJ	22.5 UJ	57.3
Beryllium	1.1 J	0.81 J	1.1 B	0.6 U	1.2 J	0.8 UJ	0.47 B
Cadmium	2.8 UJ	2.8 UJ	2.8 U	2.8 U	2.8 UJ	2.8 UJ	1.1
Calcium	238000 J	245000 J	425000	388000	9030 J	7000 J	14600
Chromium	5.9 UJ	5.9 UJ	10.4 UJ	10.4 UJ	20.4 J	5.9 UJ	17.1 J
Cobalt	15.5 UJ	15.5 UJ	15.5 UJ	15.5 UJ	15.5 UJ	15.5 UJ	23.4
Copper	5.1 UJ	7 J	20.9 J	5.1 UJ	30.6 J	5.1 UJ	77.4 J
Iron	1020 J	14.5 UJ	20200	144000	6810 J	86.7 J	35000 J
Lead	1.8 UJ	1.8 UJ	106 J	9 U	1.8 UJ	1.8 UJ	7.8
Magnesium	211000 J	217000 J	298000	541000	9020 J	5620 J	18300
Manganese	482 J	369 J	10000	9610	345 J	230 J	762 J
Mercury	2.8 J	1.4 J	0.2 UJ	0.2 UJ	0.2 UJ	0.2 UJ	0.1 U
Nickel	7.8 UJ	7.8 UJ	7.8 UJ	7.8 UJ	7.8 UJ	7.8 UJ	22
Potassium	7440 J	7870 J	35100	34000	3040 J	2990 U	647 U
Sodium	2000000 J	1920000 J	4600000 J	4570000 J	205000 J	198000 J	1580 J
Vanadium	8.5 UJ	8.5 UJ	8.5 UJ	14.3 UJ	22.2 J	8.5 UJ	89.2
Zinc	22 J	16 J	187 J	12.1 U	26 J	12.1 UJ	87 J

Qualifiers:
J - estimated value
NA - not analyzed
R - result is rejected and unusable
U - not detected
UJ - reported quantitation limit is estimated
B - value is greater than the Instrument Detection Limit but less than the Contract Required Detection Limit
E - concentration exceeds calibration range of GC/MS instrument

TABLE 4-15 (CONTINUED)
INORGANIC CHEMICALS DETECTED IN THE GROUNDWATER, SOIL, SURFACE WATER AND SEDIMENT
SITE 18 - NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

SAMPLE ID	18 SS 181C	18 SS 181D	18 SS 181E	18 SW 108	18 SED 182
	Background	Background	Background		
UNITS	mg/Kg	mg/Kg	mg/Kg	ug/L	mg/Kg
Aluminum	4030 J	12300 J	16000 J	42.9 U	14100 J
Arsenic	0.85 J	1.1 J	0.86 J	3 U	2.3 UJ
Barium	24.7 B	60.5	79.9	35.2 U	95 B
Beryllium	0.13 U	0.29 B	0.59 B	0.6 U	0.46 U
Cadmium	0.6. U	0.72 B	1.1	2.8 U	2.3 B
Calcium	341000	165000	94600	42900	62900
Chromium	7.1 J	11.8 J	15.6 J	4.9 U	24.7 J
Cobalt	2.5 B	16.8	18.6	9.6 U	21.2 B
Copper	18.9 J	39.9 J	35.1 J	5.1 U	133 J
Iron	6360 J	22300 J	30000 J	682	25300 J
Lead	20.9	57.8	16.1	1.8 U	83.8
Magnesium	3750	5680	6750	6780	9120
Manganese	145 J	605 J	562 J	104	479 J
Mercury	0.1 U	0.11 U	0.11 U	0.2 U	0.35 U
Nickel	4 U	6 B	9.2	18.7 U	16.5 B
Potassium	276 U	307 U	473 U	2720 B	1130 B
Sodium	1590 J	1480 J	1110 J	23400	1330 J
Vanadium	18.3 J	65.7	97.6	19.3 U	99.8
Zinc	21.2 J	52.5 J	62.9 J	12.1 U	361 J

Qualifiers:
J - estimated value
NA - not analyzed
R - result is rejected and unusable
U - not detected
UJ - reported quantitation limit is estimated
B - value is greater than the Instrument Detection Limit but less than the Contract Required Detection Limit
E - concentration exceeds calibration range of GC/MS instrument

TABLE 4-15 (CONTINUED)
INORGANIC CHEMICALS DETECTED IN THE GROUNDWATER, SOIL, SURFACE WATER AND SEDIMENT
SITE 18 - NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

SAMPLE ID	18 SS 173	18 SS 174	18 SS 175	18 SS 176	18 SS 177	18 SS 178DUP (18 SS 177)	18 SS 179
UNITS	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg
Aluminum	19700 J	3760 J	3210 J	8560 J	20800 J	1810 J	10900 J
Arsenic	1 UJ	2.3 J	2.9 J	79.1 J	16.4 J	30.2 J	2.5 J
Barium	109	33.8 B	16.4 B	34.9 B	89.2	59.6	27.2 B
Beryllium	0.47 B	0.15 U	0.17 U	0.14 U	0.53 B	0.4 B	0.18 B
Cadmium	0.97 U	0.68 U	0.77 U	0.67 U	1.1 B	1 B	0.7 B
Calcium	10600	466000	475000	317000	60000	9560	306000
Chromium	34 J	6.9 J	7.8 J	10.2 J	15.2 J	15.4 J	13.2 J
Cobalt	26.1	4.1 B	2.6 U	6.7 B	29.8	24.4	5.9 B
Copper	33.5 J	22.7 J	14.3 J	49.8 J	61.2 J	56.1 J	33.5 J
Iron	30800 J	7480 J	5670 J	12400 J	28800 J	24000 J	15600 J
Lead	17.1	10.8	1.5	1.6	4.7	6.9	15.6
Magnesium	19000	6120	4930	5720	13600	11900	6510
Manganese	857 J	130 J	102 J	378 J	1260 J	904 J	206 J
Mercury	0.16 U	0.12 U	0.15 U	0.1 U	0.1 U	0.11 U	0.11 U
Nickel	26.9	4.6 U	5.2 U	4.4 U	16.3	16.3	9.1
Potassium	270 U	397 U	341 U	493 U	457 U	550 U	741 U
Sodium	4940 J	3610 J	3040 J	2570 J	1520 J	1610 J	2410 J
Vanadium	95.3	20.6 J	16.1 J	45.2	98.7	79.9	45
Zinc	87.8 J	28.5 J	10.3 J	21 J	77.7 J	76.7 J	55.7 J

Qualifiers:
J - estimated value
NA - not analyzed
R - result is rejected and unusable
U - not detected
UJ - reported quantitation limit is estimated
B - value is greater than the Instrument Detection Limit but less than the Contract Required Detection Limit
E - concentration exceeds calibration range of GC/MS instrument

expectable for groundwaters occupying unconsolidated colluvium developed from a ferromanganous, igneous rock.

Soil

VOC were found as trace to moderate concentrations of acetone and carbon disulfide; the highest concentrations were of acetone in samples 18SS174 from station 18SS102 and 18SS177 from station 18SS103, both of which stations being on the downslope side of the foundation of Building 128. SVOC data are unreliable, but do not indicate significantly high concentrations. P/PCB were found randomly in trace to high concentrations. Inorganic cations of the TAL are in the range expectable for unconsolidated material in a coastal margin developed from a ferromanganous, igneous rock.

Surface Water

A sample of standing water was taken from the drainage ditch between Forrestal Drive and the foundation for Building 128.

VOC was found only as acetone in low concentration. SVOC data are unreliable, but do not indicate significantly high concentrations. P/PCB were found as trace concentrations of 4,4'-DDE and 4,4'-DDT. Inorganic cations of the TAL are in the range expectable for rainwaters moving across and through unconsolidated, colluvial material in a coastal margin developed from a ferromanganous, igneous rock.

Sediments/terrestrial

A sample of the sediment at the surface water station was taken. VOC were present as moderate to high concentrations of acetone and 2-butanone, and a moderate concentration of toluene. SVOC data are unreliable, but do not indicate significantly high concentrations. P/PCB are present in trace to high concentrations, the highest being of 4,4'-DDD.

4.4 Comparison with Data of the Confirmation Study

Evaluation of the data available on Tables 4-2 through 4-15 (from this Supplemental Investigation) against the data available in Appendix 3.A (from the Confirmation Study) indicates that the CS data reliably represent conditions at the subject sites. The data from the

CS can then be used appropriately in the evaluation of the disposition of each site; these data support the recommendations developed from the analyses of this Supplemental Investigation.

5.0 EVALUATION OF POTENTIAL HUMAN HEALTH RISK AND ECOLOGICAL EFFECTS

5.1 Introduction

This section presents the potential human health risks and ecological effects associated with potential exposure to the seven sites currently being evaluated at NSRR. Current and future (potential) land-use scenarios were assessed for each site considering no further remedial action. This evaluation has been further divided into six sections. Section 5.2 identifies chemicals of potential concern, which are the contaminants detected at the sites having the greatest potential to affect human health and the environment. Section 5.3 presents the exposure assessment, which describes the site and its potential exposure, for both current and future scenarios. Section 5.4 presents the toxicity assessment, which contains an overview of the potential toxicological effects considered in this assessment. Section 5.5 presents the risk characterization and calculations used in the evaluation of potential human health risks, in conjunction with site-specific chemical data. Section 5.5 also presents a general discussion of potential ecological effects associated with the chemicals of concern identified at individual sites. Section 5.6 discusses sources of uncertainty in the quantitative risk assessment.

5.2 Chemicals of Potential Concern

Chemicals of potential concern (COPCs) are site-related chemicals used to qualitatively or quantitatively estimate the potential human and environmental effects subsequent to exposure. Four environmental media were investigated at one or more sites at NSRR. These are soils, groundwater, surface water, and sediments. Tar samples were also taken at Site 2, however, these samples were not evaluated since they do not represent an environmental medium to which an individual could be chronically exposed. This section presents the rationale and selection of COPCs for each media at NSRR.

Base history, disposal history, frequency of detection and concentration at which chemicals were detected in environmental media were the parameters used to identify COPCs. Based on information regarding past use, chemicals associated with the sites investigated include:

- Solvents (benzene, toluene, trichloroethene, etc.)
- Pesticides (organochlorines, organophosphates, and arsenicals)
- Polychlorinated Biphenyls (PCBs)
- Polynuclear aromatic hydrocarbon (PAHs)
- Inorganics

The most recent analytical data were used in the selection of COPCs for the sites investigated (Work Plan, Baker 1992). Samples collected at this time were analyzed in accordance with USEPA Contract Laboratory Program (CLP) methodologies for target compound list (TCL) organic chemicals and target analyte list (TAL) inorganic analytes. TCL organics include volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), pesticides, and PCBs. TAL inorganics include aluminum, antimony, arsenic, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, manganese, magnesium, nickel, potassium, selenium, silver, mercury, sodium, thallium, vanadium, and zinc. These data were validated according to the National Functional Guidelines and NEESA Level D requirements. Analytical data were presented previously in Section 4.0 of this report. The following paragraphs provide a general discussion about the analytical data on a site-by-site basis.

5.2.1 Site 1 - Quebrada Disposal Site

A total of 12 soil samples and 1 sediment sample was taken from the Quebrada Disposal Site and analyzed for VOCs, SVOCs, pesticides, PCBs, and TAL inorganic compounds (TAL metals and cyanide). Three of the 12 soil samples were considered to be background samples. These background samples were not analyzed for VOCs or SVOCs.

Acetone, carbon disulfide, and toluene were detected in one or more soil samples. Acetone was also detected at 54 µg/kg in the sediment sample. Acetone is a common laboratory-related constituent. Furthermore, the volatility of acetone and the nature of the disposal site makes acetones presence in soil or sediment samples as a result of past practices unlikely. Carbon disulfide was detected at concentrations ranging from 2.0 to 59 µg/kg. Carbon disulfide is a chemical which occurs naturally in soils (Dragun, 1988) and was not retained for further evaluation as a COPC for this reason. Toluene was detected in four of nine site soil samples in concentrations ranging from 19 to 52 µg/kg. However, toluene may be present in Site 1 soils due to laboratory contamination or because it also occurs naturally in soils. Toluene is also a constituent of fuels and light oils which may have been disposed at Site 1. Thus, toluene was retained as a COPC for further evaluation.

Bis(2-ethylhexyl)phthalate, butyl benzyl phthalate and di-n-butyl phthalate were detected in two or more Site 1 soil samples and in the sediment sample. Phthalates are common laboratory or sampling induced contaminants and, therefore, were not retained for further evaluation in this assessment.

PCB-1260 was detected in one soil sample (SS-107) at 25 µg/kg. Despite the relatively low level of detection, PCB-1260 was retained as a COPC.

Inorganic analytical results for site soil compare favorably with background sample results. Inorganics were, therefore, not retained as COPCs at Site 1.

Chemicals retained as COPCs at Site 1 were:

- PCB-1260
- Toluene

5.2.2 Site 2 - Mangrove Disposal Site

A total of ten soil samples (seven site samples and three background samples) was collected at Site 2, Mangrove Disposal Site. Three sediment samples and two "tar" samples were also taken and analyzed in conjunction with site soil samples for TCL organics and TAL inorganics. Because "tar" samples are not representative of environmental media to which humans would be exposed chronically, "tar" samples were not assessed in the evaluation of human health. Background samples collected at Site 2 were not analyzed for VOCs or SVOCs.

The VOCs acetone, 2-butanone, methylene chloride and carbon disulfide were detected in one or more sediment, soil or "tar" samples taken at Site 2. Acetone, 2-butanone, and methylene chloride are considered common laboratory contaminants and may be present in these samples for this reason. Acetone, 2-butanone, and methylene chloride were, therefore, not retained for further evaluation. Carbon disulfide is known to occur naturally. Its presence in only one sediment sample does not warrant its inclusion as a COPC.

Pesticides were detected in soils and sediment samples taken at the site. The chemicals alpha-chlordane, gamma-chlordane, 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, and dieldrin were detected with

greatest frequency. These chemicals were not detected in background samples and were, therefore, retained as COPCs.

Inorganic constituents were detected in site soil samples at approximately the same concentration as background inorganic levels. Inorganics were, therefore, not retained as COPCs for Site 2 Soils. The inorganic constituent lead was detected at relatively high concentrations in Site 2 sediment samples. Lead was, therefore, retained as a COPC in sediments.

Chemicals retained as COPCs at Site 2 are:

- alpha-Chlordane
- gamma-Chlorane
- 4,4'-DDD
- 4,4'-DDE
- 4-4'-DDT
- Dieldrin
- Lead

5.2.3 Site 5 - Army Cremator Disposal Site

A total of 21 soil samples was taken at Site 5, the former Army Cremator Disposal Area. Three of the 21 soil samples were background samples. Background samples were not analyzed for VOCs or SVOCs.

Fourteen site samples were analyzed for VOCs and 15 site samples were analyzed for SVOCs. All samples were analyzed for TCL organics and TAL inorganics.

Organic chemicals of potential concern in soils selected at Site 5 include beta-BHC, delta-BHC, 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT.

Inorganic chemicals detected in site soil samples were approximately equal to background soil inorganic chemical concentrations. Inorganics were not retained as COPCs at Site 5 for this reason.

Chemicals retained as COPC for Site 5 were:

- beta-BHC
- delta-BHC
- 4,4'-DDD

- 4,4'-DDE
- 4,4'-DDT

5.2.4 Site 6 - Langley Drive Disposal Site

A total of 16 soil samples and 1 groundwater sample was collected at the Langley Drive Disposal Site. Two of the 16 soil samples were background samples. Background samples were analyzed for pesticides, PCBs, and TAL inorganics. All other samples were analyzed for TCL organics and TAL inorganic analytes.

Organic COPCs in soils selected at Site 6 include toluene, ethylbenzene, benzene, aldrin, beta-BHC, 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, endosulfan II, endrin, anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, phenanthrene, and pyrene.

Inorganic chemicals detected at concentrations exceeding background sample location analytical results include arsenic, barium, copper, lead, and zinc.

Chemicals retained as COPCs for Site 6 were:

- Toluene
- Ethylbenzene
- Benzene
- Aldrin
- beta-BHC
- 4,4'-DDE
- 4,4'-DDD
- 4,4'-DDT
- Endosulfan II
- Endrin
- Benzo(a)pyrene
- Benzo(b)fluoranthene
- Benzo(k)fluoranthene
- Benzo(g,h,i)perylene
- Chrysene
- Dibenz(a,h)anthracene
- Indeno(1,2,3-cd)pyrene
- Phenanthrene
- Pyrene
- Arsenic
- Barium
- Copper
- Lead
- Zinc

TCL organic compounds and TAL inorganic analytes were not detected in the groundwater sample taken during the investigation.

5.2.5 Site 10 - Building 25 Storage Area

A total of eight soil samples were taken at the Building 25 Storage Area. Three of the eight soil samples were taken from background locations. With the exception of the background

samples, samples were analyzed for TCL compounds and TAL inorganic analytes. Background samples were analyzed for pesticides, PCBs, and TAL inorganics only.

Organic COPCs in soils selected for further evaluation include 4,4'-DDE, 4,4'-DDT, acenaphthene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, chrysene, dibenz(a,h)anthracene, fluoranthene, indeno(1,2,3-cd)pyrene, phenanthrene, and pyrene.

Inorganic COPCs selected for further evaluation include chromium, lead, and zinc.

Three chemicals were detected in site samples at concentrations exceeding site background.

Chemicals retained as COPCs at Site 10 were:

- 4,4'-DDT
- 4,4'-DDE
- Acenaphthene
- Anthracene
- Benzo(a)anthracene
- Benzo(a)pyrene
- Benzo(b)fluoranthene
- Benzo(g,h,i)perylene
- Chrysene
- Dibenz(a,h)anthracene
- Indeno(1,2,3-cd)pyrene
- Fluoranthene
- Phenanthrene
- Pyrene
- Chromium
- Lead
- Zinc

5.2.6 Site 14 - Ensenada Honda Shoreline and Mangroves

One groundwater and six sediment samples were taken from the Ensenada Honda Shoreline and Mangroves. Sediments were analyzed for TCL compounds and TAL inorganics. The background sample was also analyzed for TCL organic and TAL inorganics. The groundwater sample was analyzed for VOCs exclusively.

VOCs were not detected in site groundwater. Toluene was detected at 120 µg/kg in the background sediment sample. Other chemicals detected in the background sediment sample include methylene chloride and carbon disulfide. VOCs were, therefore, not considered COPCs at Site 14 because they were not detected at significantly higher concentrations in site samples.

Chemicals retained as COPCs in Site 14 sediments include aldrin, alpha-BHC, and 4,4'-DDT. Inorganics were not retained as COPCs because the levels detected in site samples were approximately equal to the results obtained from the background sample, with the exception of SED167. Inorganic results reported for this sample were approximately two to ten times higher than other site sediment samples, suggesting that SED167 results are analytical anomalies possibly related to the sample matrix.

Chemicals retained as COPCs for Site 14 were:

- aldrin
- alpha-BHC
- 4,4'-DDT

5.2.7 Site 18 - Pest Control Shop and Surrounding Area

A total of 6 groundwater, 11 soil, 1 surface water, and 1 sediment sample were taken from the Pest Control Shop and Surrounding Area. Site samples were analyzed for TCL compounds and TAL analytes. Three of the soil samples were taken from background sampling locations. Background soil samples were not analyzed for TCL VOCs and TCL SVOCs.

One groundwater sample contained detectable levels of tetrachloroethene equal to its Federal Maximum Contaminant (MCL) level of 5.0 µg/L. Tetrachloroethene was not detected in any other groundwater sample. Tetrachloroethene was retained as a COPC in groundwater.

Groundwater samples did not contain detectable levels of pesticides, PCBs, or SVOCs with the exception of the common laboratory contaminant bis(2-ethylhexyl)phthalate (GW102 - 2 µg/L). Pesticides, PCBs, and SVOCs were, therefore, not retained for further consideration.

COPCs in soil retained for further evaluation include alpha-chlordane, gamma-chlordane, 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, chrysene, fluoranthene, indeno(1,2,3-cd)pyrene, pyrene, and arsenic.

Surface water and/or sediment sample COPCs include toluene, alpha-chlordane, 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, and endosulfan I.

Chemicals retained as COPCs for Site 18 were:

- alpha-Chlordane
- gamma-Chlordane
- 4,4'-DDD
- 4,4'-DDT
- 4,4'-DDE
- Benzo(a)anthracene
- Indeno(1,2,3-cd)pyrene
- Benzo(b)fluoranthene
- Chrysene
- Fluoranthene
- Endosulfan I
- Benzo(a)pyrene
- Pyrene
- Arsenic

5.3 Exposure Assessment

5.3.1 Exposure Pathways and Potential Receptors

The following paragraphs present a description of the conditions at each site and the potential human and ecological receptors selected for evaluation.

Site 1 - Quebrada Disposal Site

The Quebrada Disposal Site is located to the south of North Shore Road (Route 70) in the north-central portion of NAF Vieques. The site was used from the 1960s to the late 1970s by civilian and U.S. Navy personnel. Site 1 boundaries lie within and adjacent to a quebrada (dry stream bed) which discharges to the Vieques Passage and ultimately the Atlantic Ocean when sufficient precipitation occurs. Access to the site is obtained by a dirt road which connects the site to Route 70.

The quebrada has been reported to vary from 20 to 30 feet in width and 10 to 20 feet in depth. Disposal of materials occurred by tumbling wastes over the side of the quebrada. This method of disposal, in conjunction with the physical characteristics of Site 1, limits the potential for human exposure. It was assumed, for the sake of conservatism, that an older child could trespass to investigate the disposed materials in the quebrada and subsequently be exposed to COPCs by dermal contact and incidental ingestion with soils and sediments. No other human exposure pathways were considered likely, either now or in the future, due to the limited access and physical characteristics of the site.

Site 2 - Mangrove Disposal Site

The mangrove disposal site is located in the northwestern portion of Vieques Island along North Shore Road (Route 70). The site stretches along North Shore Road for approximately 300 feet, and extends into a seaside mangrove swamp for about 100 feet. The site is located immediately east of the Laguna Kiani Bridge, between Laguna Kiani and the Vieques Passage.

Potential current human receptors are limited to trespassing adults accessing the site for fishing and crabbing in the mangrove swamp and contacting COPCs present in soils and sediments. Future development of Site 2 for any purpose is highly unlikely due to the physical characteristics of the site. Ecological receptors such as the manatee and various sea turtle species could also be affected by COPCs present in surface waters, or partitioning from sediments to surface waters.

Site 5 - Army Cremator Disposal Area

The Army Cremator Disposal Area is located south of the intersection of the access road to the Ammo Pier (now the Coast Guard Pier) and Langley Drive, west and southwest of the Navy Exchange and Bowling Alley, and in and near the Ensenada Honda mangrove swamp.

Access to Site 5 from the Navy Exchange and other businesses along Langley Drive is currently limited. It is possible, although unlikely, that adolescents or adults could gain access to Site 5 on a limited basis, thus, potentially contacting COPCs present in surface soils. Future industrial development of Site 5, although unlikely, is a possibility. Therefore, future workers at Site 5 were also evaluated.

The mangroves present at Site 5 are considered to be ecologically important to the food chain. The disposal area and the mangroves are designated by NSRR as a habitat for the short-eared owl, yellow-shouldered blackbird, reddish, snowy, and common egret, and osprey.

Site 6 - Langley Drive Disposal Site

The Langley Drive Disposal Site is located just north of the Navy Exchange Complex, 300 feet east of the drive towards Ensenada Honda. The site is within the perimeter of the Ensenada Honda mangrove area.

Trespassers (children and adults) could be exposed to COPCs present in soils through dermal contact and accidental ingestion during their excursions. Future development of Site 6 for any purpose is unlikely due to the physical characteristics of the site. Ecological receptors inhabiting the mangrove area could potentially be affected by COPCs in surface waters and sediments. Stressed vegetation is apparent at the site which may or may not be associated with past disposal practices.

Site 10, - Building 25 Storage Area

Building 25 was originally used for the storage of Public Works - Supply Department material, but was later turned over to the Defense Property Disposal Office. Building 25 collapsed in 1979. The site contained materials within the collapsed building and throughout the storage area along various access roads in the vicinity of Building 25. Much of the refuse at Site 10 has been removed and new construction has been undertaken within the site's boundaries. The construction of the new building(s) limits the potential for human exposure to base personnel who may contact COPCs present in soils through dermal contact and accidental ingestion during building maintenance activities. However, for the sake of conservatism, trespassers were also evaluated.

Site 14 - Ensenada Honda Shoreline and Mangroves

A fuel leak in the vicinity of Berthing Pier Number 3 is thought to be responsible for the presence of COPCs in the Ensenada Honda mangrove swamp and shoreline. The mangrove swamp and the shoreline areas are inaccessible to human receptors from a direct contact (dermal contact and accidental ingestion) perspective. However, people engaged in fishing activities (adults and older children) could be exposed to COPCs present in sediments.

Aquatic ecological receptors are the primary receptors exposed to COPCs in the surface waters and sediments of Ensenada Honda.

Site 18, - Pest Control Shop and Surrounding Area

The Pest Control Shop (Building 258) stored pesticides from the late 1950s through 1983. Pesticides were also stored on the parking apron of Building 258. A drainage ditch behind

Building 258 received pesticide spill runoff as well as rinse waters from the cleaning of pesticide equipment. Excess pesticides were also poured into the ditch.

Trespassers and base personnel could potentially be exposed to COPCs present in surface soils, ditch surface waters, and ditch sediments by dermal contact and accidental ingestion. Base personnel might also be exposed to pesticides present in soils at Site 18.

Potential human receptors were identified at each site investigated at NSRR. Table 5-1 presents a summary of the human receptors retained for further evaluation at each site.

5.3.2 Exposure Factors

Each receptor can be exposed to COPCs in environmental media in different ways. For example, trespassers (children and adults) could contact COPCs in surface soils by incidental ingestion and absorption through the skin. However, the exposure frequency would be lower for trespassers than for base personnel or future workers. Furthermore, future construction workers and their respective exposure duration is lower than the exposure duration for on-base personnel who could potentially be exposed dermally and through accidental ingestion. Exposure factors for each potential receptor are presented in Table 5-2. USEPA promulgated exposure factors were used in conjunction with professional judgment to estimate exposure. In some cases, USEPA default values were modified to accommodate site-specific conditions as is the case with surface water exposure times and frequencies. The sources for all exposure factors and deviations from USEPA default exposure factors are also presented in Table 5-2.

5.4 Toxicity Assessment

Section 5.3 identified potential exposure pathways and potentially affected populations for the evaluations of potential human health risks and ecological effects. This section presents the available toxicological information for the selected COPCs.

TABLE 5-1

POTENTIAL RECEPTORS SELECTED FOR FURTHER EVALUATION
AT EACH SITE
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Site	Potential Receptors				
	Trespassing Children (6-15 years)	Trespassing Adults	Base Personnel	Future Workers	Ecological
1	X				
2	X	X			X
5	X	X		X	X
6	X	X			X
10	X	X	X		
14	X	X			X
18	X	X	X		X

TABLE 5-2

SUMMARY OF EXPOSURE FACTORS FOR EACH
POTENTIAL HUMAN RECEPTOR(1)(2)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Exposure Factors	Future Worker	Base Personnel	Trespassing Adults	Trespassing Children
*INGESTION RATES				
Soils	480 mg/d	50 mg/d	50 mg/d	100 mg/d
Surface Water	NA	NA	NA	0.05 L/hr
Sediments	NA	50 mg/d	50 mg/d	100 mg/d
*ADHERENCE RATES				
Soils	1.0 mg/cm^2	1.0 mg/cm^2	1.0 mg/cm^2	1.0 mg/cm^2
Sediments	NA	1.0 mg/cm^2	1.0 mg/cm^2	1.0 mg/cm^2
*EXPOSED SURFACE AREA				
Soils	5,300 cm^2	2,000 cm^2	5,300 cm^2	5,300 cm^2
Surface Water (Swimming)	NA	NA	NA	15,700 cm^2
Sediments	NA	2000 mg/d	5,300 cm^2	7,100 cm^2
*EXPOSURE FREQUENCY				
Soils	300 d/yr	250 d/yr	100 d/yr	100 d/yr
Surface Water	NA	NA	100 d/yr	100 d/yr
Sediments	NA	NA	100 d/yr	100 d/yr
*EXPOSURE DURATION				
Soils	1 yr	25 yrs	30 yrs	9 yrs
Surface Water	NA			9 yrs
Sediments	NA	25 yrs	30 yrs	9 yrs
*EXPOSURE TIME				
Surface Water	NA	NA	NA	5 hr/d(3)
*BODY WEIGHT				
All Scenarios	70 kg	70 kg	70 kg	45 kg

TABLE 5-2 (Continued)

SUMMARY OF EXPOSURE FACTORS FOR EACH
POTENTIAL HUMAN RECEPTOR(1)(2)
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Exposure Factors	Future Worker	Base Personnel	Trespassing Adults	Trespassing Children
*AVERAGING TIME(4)				
Surface Soils	365 d	9,125 d	10,950 d	3,285 d
Surface Water	NA	NA	NA	3,285 d
Sediments	NA	9,125d	10,950 d	3,285 d

Notes: NA = Not Applicable
Trespassing children = 6 years to 15 years of age
(1) Exposure Factors Handbook. EPA/600/8-89/043.
(2) Risk Assessment Guidance for Superfund Vol. I. EPA/540/1-89/002.
(3) National average value for swimming exposure time x 2.0 to account for geographical difference.
(4) Noncarcinogenic constituent averaging time value. Carcinogenic averaging time is 25,550 days.
(70 yr x 365 days/yr) for every receptor and scenario.

5.4.1 Toxicological Evaluation

The purpose of this section is to identify the potential health and environmental effects associated with hypothetical exposures to the COPCs identified in Section 5.2. A toxicological evaluation characterizes the inherent toxicity of a compound. It consists of the review of current scientific data to determine the type and magnitude of the potential human health and environmental effects associated with potential exposure to a chemical. The end product is a collection of toxicological profiles for the COPCs.

Toxicological profiles addressing the COPCs at NSRR are presented in Appendix 5.A. In these toxicological profiles, the available human and animal data are presented. Human data from occupational exposures are often insufficient for determining quantitative indices of toxicity because of uncertainties in exposure estimates, and inherent difficulties in determining causal relationships established by epidemiological studies. For this reason, animal bioassays are conducted under controlled conditions and their results are extrapolated to humans. There are several stages to this extrapolation. First, to account for species differences, conversion factors are used to extrapolate from test animals to humans. Second, the relatively high doses administered to test animals must be extrapolated to the lower doses more typical of human exposures. For noncarcinogens, safety factors and modifying factors are applied to animal results when developing acceptable human doses. For carcinogens, mathematical models are used to extrapolate effects at high doses to effects at lower doses. Epidemiological data can then be used for inferential purposes to establish the credibility of the experimentally derived indices.

Toxic effects considered in these profiles include noncarcinogenic (toxic) and potentially carcinogenic health effects as well as environmental effects. Toxicological endpoints, routes of exposure, and doses in humans and/or animal studies are discussed. Routes of exposure and doses in humans and/or animal studies are provided. Also considered is the USEPA's weight-of-evidence of a compound's carcinogenicity (i.e., Group A, known human carcinogens; Group B, probable human carcinogens; Group C, possible human carcinogens; Group D, not classifiable as to its carcinogenicity). Environmental effects include acute and chronic toxic effects observed in aquatic biota and terrestrial receptors.

The available toxicological information indicates that exposure to many of the COPCs may result in both noncarcinogenic and potential carcinogenic health effects in humans and/or in experimental animals. Although the COPCs may potentially cause adverse health and

environmental impacts, dose-response relationships and the potential for exposure must be evaluated before the risk to receptors can be determined. Dose-response relationships correlate the magnitude of the dose with the probability of toxic effects.

5.4.2 Dose-Response Evaluation

An important component of the evaluation of human health effects is the relationship between the dose of a compound (amount to which an individual or population is potentially exposed) and the potential for adverse health effects resulting from exposure to that dose. Dose-response relationships provide a means by which potential public health impacts may be evaluated. The published information on doses and responses is used in conjunction with information on the nature and magnitude of exposure to develop an estimate of risk. Standard reference doses and/or carcinogenic slope factors have been developed for many of the COPCs. This section provides a brief description of these parameters.

Reference Doses (RfD) - The RfD is developed for chronic and/or subchronic human exposure to chemicals and is based solely on the noncarcinogenic effects of chemical substances. It is defined as an estimate of a daily exposure level for the human population, including sensitive subpopulations, that is likely to be without an appreciable risk of adverse effects during a lifetime. The RfD is usually expressed as dose (mg) per unit body weight (kg) per unit time (day). It is generally derived by dividing a no-observed-(adverse)-effect-level (NOAEL or NOEL) or a lowest observed-adverse-effect-level (LOAEL) for the critical toxic effect by an appropriate "uncertainty factor (UF)." Effect levels are determined from laboratory or epidemiological studies. The uncertainty factor is based on the availability of toxicity data.

Uncertainty factors usually consist of multiples of 10, where each factor represents a specific area of uncertainty naturally present in the extrapolation process. These uncertainty factors are presented below and were taken from the Risk Assessment Guidance Document for Superfund, Volume I, Human Health Evaluation Manual (Part A) (USEPA, 1989):

- A UF of 10 is used to account for variation in the general population and is intended to protect sensitive subpopulations (e.g., elderly, children).

- A UF of 10 is used when extrapolating from animals to humans. This factor is intended to account for the interspecies variability between humans and other mammals.

- A UF of 10 is used when a NOAEL, derived from a subchronic instead of a chronic study, is used as the basis for a chronic RfD.

- A UF of 10 is used when a LOAEL is used instead of a NOAEL. This factor is intended to account for the uncertainty associated with extrapolating from LOAELs to NOAELs.

In addition to UFs, a modifying factor (MF) is applied to each reference dose and is defined as:

- An MF ranging from >0 to 10 is included to reflect a qualitative professional assessment of additional uncertainties in the critical study and in the entire data base for the chemical not explicitly addressed by the preceding uncertainty factors. The default value for the MF is 1.

Thus, the RfD incorporates the certainty of the evidence for chronic human health effects. Even if applicable human data exist, the RfD still maintains a margin of safety so that chronic human health effects are not underestimated.

Carcinogenic Slope Factor (CSF) - Carcinogenic slope factors are used to estimate an upper-bound lifetime probability of an individual developing cancer as a result of exposure to a particular level of a potential carcinogen (USEPA, 1989). This factor is generally reported in units of $(mg/kg/day)^{-1}$ and is derived through an assumed low-dosage linear multi-stage model and an extrapolation from high to low dose responses determined from animal studies. The value used in reporting the slope factor is the upper 95 percent confidence limit.

These slope factors are also accompanied by weight-of-evidence classifications which designate the strength of the evidence that the COPC is a potential human carcinogen.

Ambient Water Quality Criteria (AWQC) - AWQC are nonenforceable Federal regulatory guidelines and are of primary utility in assessing potential acute and chronic toxic effects in aquatic organisms. AWQCs consider acute and chronic effects in both freshwater and saltwater aquatic life. The criteria for the protection of aquatic life specify pollutant concentration which, if not exceeded, should protect most, but not necessarily all aquatic life. The aquatic life criteria specify maximum (derived from acute toxicity data) and 24-hour

average values (chronic). The combination of the two values is designed to provide adequate protection of aquatic life from acute and chronic toxicity and bioaccumulation.

National Oceanic and Atmospheric Administration (NOAA) Sediment Screening Values - NOAA sediment screening values are interim Federal criteria for the protection of aquatic life used by USEPA until other sediment quality criteria can be developed. NOAA developed these screening values through evaluation of biological effects data for marine and freshwater aquatic organisms, obtained through equilibrium partitioning calculations, spiked sediment bioassays, and biological and chemical field surveys. For each constituent having sufficient data available, the concentrations causing adverse biological effects were arrayed, and the lower 10 percentile (called an Effects Range-Low, or ER-L) and the median (called an Effects Range-Median, or ER-M) were determined.

If sediment contaminant concentrations are above ER-M, adverse effects on the biota are considered probable. If contaminant concentrations are between the ER-L and ER-M, adverse effects are considered possible, and EPA recommends conducting sediment toxicity tests as a follow-up. If contaminant concentrations are below the ER-L, adverse effects are considered unlikely.

Quantitative indices of toxicity and USEPA weight-of-evidence classifications are presented in Table 5-3 for the COPCs. The USEPA weight-of-evidence categories are explained in Table 5-4. The hierarchy (USEPA, 1989) for choosing these values is as follows:

- Integrated Risk Information System (IRIS) (USEPA 1993)
- Health Effects Assessment Summary Table (HEAST) (USEPA 1992a)

The IRIS data base is updated monthly and contains both verified RfDs and CSFs. The USEPA has formed an RfD Work Group to review existing data used to derive RfDs. Once this task has been completed, the verified RfD appears in IRIS. Like the RfD Work Group, the USEPA has also formed the Carcinogen Risk Assessment Verification Endeavor (CRAVE) Work Group to review and validate toxicity values used in developing CSFs. Once the slope factors have been verified via extensive peer review, they also appear in the IRIS data base.

HEAST, on the other hand, provides both interim (unverified) and verified RfDs and CSFs. This document is published quarterly and incorporates any applicable changes to its data base.

TABLE 5-3

CANCER SLOPE FACTORS AND REFERENCE DOSES FOR COPCs
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Compound	Cancer Slope Factor Oral(1)(4)	Relative Potency Estimate(5)	Reference Dose (RfD) Oral(2)(4)	Weight-of-Evidence Classification(3)
Acenaphthene	--	--	0.06	D
Acenaphthylene	--	--	--	D
Aldrin	17.0	--	0.00003	B2
alpha-Chlordane	1.3	--	--	B2
Anthracene	--	--	0.3	D
Arsenic	1.75	1.75	0.0003	A
Benzene	0.029	--	--	A
Benzo(a)anthracene	--	0.73	--	B2
Benzo(a)pyrene	7.3	7.3	--	B2
Benzo(b)fluoranthene	--	0.73	--	B2
Benzo(g,h,i)perylene	--	--	--	D
Benzo(k)fluoranthene	--	0.73	--	B2
Cadmium	--	--	0.0005	D
Chromium	--	--	0.005	D
Chrysene	--	0.073	--	B2
DDE	0.34	--	0.0005	B2
DDT	0.34	--	0.0005	B2
Dibenz(a,h)anthracene	--	7.3	--	B2
Dieldrin	16.0	--	--	B2
Endosulfan	--	--	0.0005	D
Ethylbenzene	--	--	0.1	D
Fluoranthene	--	--	0.04	D
Fluorene	--	--	0.04	D
gamma-Chlordane	1.3	--	--	B2
Heptachlor	4.5	--	0.0005	B2
Indeno(1,2,3-cd)pyrene	--	0.73	--	B2

TABLE 5-3

CANCER SLOPE FACTORS AND REFERENCE DOSES FOR COPCs
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Compound	Cancer Slope Factor Oral[1][4]	Relative Potency Estimate[5]	Reference Dose (RfD) Oral[2][4]	Weight-of-Evidence Classification[3]
Lead	--	--	--	B2
Naphthalene	--	--	0.004	D
PCBs	7.7	--	--	B2
Phenanthrene	--	--	--	D
Pyrene	--	--	0.03	ND
Toluene	--	--	0.2	D
Xylenes	--		2.0	D
Zinc	--	--	0.3	D

Notes: ND = Not Determined
-- = Not Available or Applicable
(1) units of (1/mg/kg/day)
(2) units of (mg/kg/day)
(3) See Table 5-4 for description of classification
(4) Taken from USEPA Health Effects Assessment Summary Table, FY 1992 USEPA IRIS Data Base On-Line, 1993.
(5) Interim Region IV Guidance, February 1992.

TABLE 5-4

EPA WEIGHT OF EVIDENCE
CATEGORIES FOR CARCINOGENIC COPCs
NAVAL STATION ROOSEVELT ROADS
PUERTO RICO

EPA Category	Description of Group	Description of Evidence
Group A	Human Carcinogen	Sufficient evidence from epidemiologic studies to support a causal association between exposure and cancer
Group B1	Probable Human Carcinogen	Limited evidence of carcinogenicity in humans from epidemiologic studies
Group B2	Probable Human Carcinogen	Sufficient evidence of carcinogenicity in animals, inadequate evidence of carcinogenicity in humans
Group C	Possible Human Carcinogen	Limited evidence of carcinogenicity in animals
Group D	Not Classified	Inadequate evidence of carcinogenicity in animals
Group E	No Evidence of Carcinogenicity in Humans	No evidence for carcinogenicity in at least two adequate animal tests or in both epidemiologic and animal studies

Dose-response relationships for environmental effects are limited to comparison with the AWQC for the protection of aquatic life or NOAA sediment screening values. These criteria specify the concentration of a compound in surface water which, if not exceeded, should protect most aquatic life. These criteria are derived from both plant and animal data and were developed to protect the types of organisms necessary to support a healthy aquatic community. AWQC consider both acute (short-term) and chronic (long-term) effects. AWQC and NOAA screening values for potential COPCs identified in surface waters are provided in Table 5-5.

5.5 Risk Characterization

The potential carcinogenic risks and noncarcinogenic health effects associated with current and future hypothetical exposures to human receptors are presented in this section. The Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (RAGS) (Parts A and B) was used in the characterization of risk. Other documents used in the characterization include:

- Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors." OSWER Directive 9285.6-03 (USEPA 1991).
- USEPA Region IV. Interim Region IV Guidance (USEPA 1992).
- USEPA (1989a) Exposure Factors Handbook. EPA/600/8-89-043

In general, risk assessments performed at other hazardous waste sites employ site-specific data to obtain chronic daily intakes (CDIs) for each receptor exposed by various pathways. CDIs are then evaluated by a comparison to available toxicological indices to produce either an incremental lifetime cancer risk value (ICR) or a hazard index (HI). The ICR and HI values for all logical exposure pathways are then summed to determine a total site ICR or HI for each receptor being evaluated. Total site ICRs are compared to USEPA's target risk range of 10^{-6} to 10^{-4} and HIs are compared to unity (1.0) to determine the potential for systemic health effects to occur subsequent to exposure. USEPA's risk range of 10^{-6} to 10^{-4} represents USEPA's opinion on what are generally acceptable (risk) levels (NCP, 1990). HIs below 1.0 indicate that noncarcinogenic health effects are unlikely even for potentially sensitive populations. Risk management decisions are then made to determine what remedial actions (if any) are necessary at the site.

TABLE 5-5

AMBIENT WATER QUALITY CRITERIA AND SEDIMENT SCREENING VALUES
PROTECTIVE OF AQUATIC LIFE
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Chemical	Ambient Water Quality Criteria				NOAA Sediment Criteria	
	Freshwater		Marine		Marine and Freshwater	
	Acute	Chronic	Acute	Chronic	ER-L	ER-M
Aldrin	3.0	--	1.3	--	--	--
alpha-BHC	100.0	--	0.34	--	--	--
delta-BHC	100.0	--	0.34	--	--	--
gamma-BHC	100.0	--	0.34	--	--	--
alpha-Chlordane	2.4	0.0043	0.09	0.004	0.5	6.0
gamma-Chlordane	2.4	0.043	0.09	0.004	0.5	6.0
4,4'-DDD	--	--	--	--	2.0	20.0
4,4'-DDE	1,050	--	14	--	2.0	15.0
4,4'-DDT	1.1	0.001	0.13	0.001	1.0	7.0
Dieldrin	2.5	0.0019	0.71	0.0019	0.02	8.0
Endosulfan I	0.22	0.056	0.034	0.0087	--	--
Endrin	0.18	0.0023	0.037	0.0023	0.02	45.0
Endrin aldehyde	--	--	--	--	--	--
Heptachlor	0.52	0.0038	0.053	0.0036	--	--
Heptachlor epoxide	0.52	0.0038	0.053	0.0036	--	--
Methoxychlor	--	0.03	--	0.03	--	--
Acenaphthene	1,700.0	520.0	970.0	500.0	150.0	650.0
Benzene	5,300.0	--	5,100.0	700.0	--	--
Benzo(a)pyrene	--	--	--	--	400.0	2,500.0
Chrysene	--	--	--	--	400.0	2,800.0

TABLE 5-5 (Continued)

AMBIENT WATER QUALITY CRITERIA AND SEDIMENT SCREENING VALUES
PROTECTIVE OF AQUATIC LIFE
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Chemical	Ambient Water Quality Criteria				NOAA Sediment Criteria	
	Freshwater		Marine		Marine and Freshwater	
	Acute	Chronic	Acute	Chronic	ER-L	ER-M
Dibenz(a)anthracene	--	--	--	--	60.0	260.0
Ethylbenzene	32,000.0	--	430.0	1,400.0	--	--
Fluoranthene	3,980.0	--	40.0	16.0	600.0	3,600.0
Fluorene	--	--	--	--	35.0	640.0
Naphthalene	2,300.0	620.0	2,350.0	--	340.0	2,100.0
PAHs	--	--	300.0	--	4,000.0	35,000.0
PCBs	2.0	0.014	10.0	0.03	50.0	400.0
Toluene	17,500.0	--	6,300.0	5,000.0	--	--
Xylenes	--	--	--	--	--	--
Arsenic	4.4	40.0	69.0	36.0	33.0	85.0
Cadmium	3.9	1.1	43.0	9.3	5.0	9.0
Chromium (+3)	1,700.0	210.0	10,300.0	--	80.0	145.0
Chromium (+6)	16.0	11.0	1,100.0	50.0	--	--
Copper	18.0	12.0	2.9	--	70.0	390.0
Lead	8.2	3.2	140.0	5.6	35.0	110.0
Nickel	1,800.0	96.0	140.0	7.1	30.0	50.0
Zinc	320.0	47.0	170.0	58.0	120.0	270.0

Notes: All values are in µg/L (surface water) or mg/kg (sediment).
ER-L = Effective Range-Low. Contaminant levels below this value are unlikely to produce adverse effects.
ER-M = Effective Range-Median. Contaminant concentrations above the ER-M are considered probable.
If contaminant concentrations are between the ER-L and ER-M, adverse effects are considered to be possible.

The risk characterization for NSRR has been conducted somewhat differently due to the number of individual sites evaluated in the risk assessment. In this assessment target levels protective of the 10^{-6} ICR level (USEPA's point of departure) and an HI of 1.0 were developed for each receptor medium and exposure pathway discussed in Section 5.3 of this report. Target levels were compared to the analytical data for each media sampled at the sites. Due to the limited analytical data available for each site, maximum COPC concentrations were used in the comparison. Maximum COPC concentrations were divided by the respective target level. Dividing the maximum COPC value by a target level produces a ratio of the concentration versus the risk based target level protective of a receptor. Summing the ratios for carcinogenic COPCs and noncarcinogenic COPCs provided a total ICR or HI value for the most conservative exposure scenario. These values were reported as presented in RAGS.

Conducting the evaluation of human health risks and ecological effects in this manner satisfies the National Contingency Plan (EPA, 1990) (NCP) purpose of the baseline risk assessment [Section 300.430(d)].

The following paragraphs present the equations used to develop pathway specific risk based target levels for each site at NSRR.

5.5.1 Dermal Contact and Accidental Ingestion of Soils and Sediments

Target levels for COPCs in soils or sediments were derived using the following general equations:

Carcinogenic COPCs

$$\text{Target Level} = \frac{\text{ICR} \times \text{BW} \times \text{AT} \times 365\ \text{d/yr}}{\text{EF} \times \text{ED} \times [\text{CSF} \times \text{IR}_{soil} \times \text{CF}) + (\text{CSF} \times \text{SA} \times \text{AD} \times \text{AF} \times \text{CF})]}$$

where:
- ICR = incremental lifetime cancer risk (10^{-6})
- CSF = oral cancer slope factor $(\text{mg/kg-d})^{-1}$
- BW = body weight (45, 70 kg)
- AT = averaging time (70 years)
- EF = exposure frequency (d/yr)
- ED = exposure duration (years)
- IR_{soil} = ingestion rate (mg/d)
- CF = conversion factor (10^{-6} kg/mg)
- SA = skin surface area (cm^2)

AD = adherence factor (1.0 mg/cm^2)
AF = dermal absorption factor (1.0 percent for organics, 0.1 for inorganics)

Noncarcinogenic COPCs

$$\text{Target Level (mg/kg)} = \frac{\text{HI x BW x AT x 365 d/yr}}{\text{EF x ED x [(1/RfD x IR}_{soil}\text{ x CF) + (1/RfD x SA x AD x AF x CF)}}$$

where: HI = total hazard index (1.0)
RfD = oral reference dose (mg/kg·d)
BW = body weight (45, 70 kg)
AT = averaging time (70 years)
EF = exposure frequency (d/yr)
ED = exposure duration (years)
IR_{soil} = ingestion rate (mg/d)
CF = conversion factor (10^{-6} kg/mg)
SA = skin surface area (cm^2)
AD = adherence factor (1.0 mg/cm^2)
AF = dermal absorption factor (1.0 percent for organics, 0.1 for inorganics)

5.5.2 Dermal Contact and Accidental Ingestion of Surface Water

The following general equations were used to develop target levels protective of human health for surface waters:

Carcinogenic COPCs

$$\text{Target Level (mg/L)} = \frac{\text{ICR x BW x AT x 365 d/yr}}{\text{EF x ED x ET x CSF x [(IR) + (SA x PC x CF)]}}$$

where: ICR = incremental lifetime cancer risk (10^{-6})
BW = body weight (45, 70 kg)
AT = averaging time (70 years)
EF = exposure frequency (d/yr)
ED = exposure duration (years)
ET = exposure time (hrs/d)
CSF = oral cancer slope factor (mg/kg·d)$^{-1}$
IR = ingestion rate (L/hr)
SA = skin surface area (cm^2)
PC = permeability constant (cm^2/hr)
CF = conversion factor (10^{-6} kg/mg)

Noncarcinogenic COPCs

$$\text{Target Level} = (\text{mg/L}) \frac{\text{HI x BW x AT x 365 d/yr}}{\text{EF x ED x ET x 1/RfD x [(IR) + (SA x PC x CF)]}}$$

where: HI = total hazard index (1.0)
BW = body weight (45, 70 kg)
AT = averaging time (70 years)
EF = exposure frequency (d/yr)
ED = exposure duration (years)
ET = exposure time (hr/d)
RfD = oral reference dose (mg/kg-d)
IR = ingestion rate (L/hr)
SA = skin surface area (cm^2)
PC = permeability constant (cm/hr)
CF = conversion factor (10^{-3} L/cm^3)

5.5.3 Comparison of Target Levels to Media Concentrations

Risks to each receptor were quantified by dividing media-specific concentrations of COPC by their target concentrations. Total HIs and ICRs were derived using the following equation:

$$\text{Total ICR or HI} = \sum_{i=1}^{n} \frac{\text{COPC}_i \text{ (mg/kg)}}{\text{Target level}i \text{ (mg/kg)}}$$

Total ICRs generated using this equation are of the 10^{-6} order of magnitude, because target levels were based on the 10^{-6} risk level. HI values are as they appear because target levels were calculated to correspond to an HI of 1.0. Target level calculations are presented in Appendix 5.B.

5.5.4 Potential Human Health Risks

Quantitative results for the evaluation of human health are presented in Tables 5-6 through 5-14. Risk results are specific to the media investigated at each site during the RI.

ICR values ranged from 2×10^{-9} (Site 14) to 2.8×10^{-5} (Site 18). All ICR values for NSRR fell within or below USEPA's target risk range of 10^{-6} to 10^{-4}. Similarly, HI values were all below 1.0, suggesting that adverse systemic health effects will not occur subsequent to the types of exposures evaluated at the sites. Quantitative results for ditch surface waters were not presented in tabular form. ICR and HI values associated with dermal contact and accidental

TABLE 5-6

SITE 1 - QUEBRADA DISPOSAL SITE
INCREMENTAL LIFETIME CANCER RISKS AND HAZARD INDICES
ASSOCIATED WITH POTENTIAL EXPOSURE TO SOILS
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Chemicals of Potential Concern	Maximum Detected Concentration (mg/kg)	Trespassing Child Target Level (mg/kg)	Trespassing Adult Target Level (mg/kg)	Soil Concentration / Target Level(1)
Carcinogens				
PCB-1260	0.025	1.0	0.8	0.03
Total				0.03
ICR				3.0×10^{-8}
Noncarcinogens				
Toluene	0.052	210,000	490,000	<0.001
Total				<0.001
ICR				<0.001

(1) Calculated for the most conservative exposure scenario. Carcinogens were evaluated using Trespassing Adults. Noncarcinogens were evaluated using Trespassing Child target levels.

TABLE 5-7

SITE 2 - MANGROVE DISPOSAL SITE
INCREMENTAL LIFETIME CANCER RISKS AND HAZARD INDICES
ASSOCIATED WITH POTENTIAL EXPOSURE TO SOILS
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Chemicals of Potential Concern	Maximum Detected Concentration (mg/kg)	Trespassing Child Target Level (mg/kg)	Trespassing Adult Target Level (mg/kg)	Soil Concentration/ Target Level[1]
Carcinogens				
alpha Chlordane	0.003	6.4	4.5	0.0007
gamma Chlordane	0.0035	6.4	4.5	0.008
4,4'-DDD	0.00048	--	--	--
4,4'-DDE	0.0028	24.6	17.0	0.0002
4,4'-DDT	0.0074	24.6	17.0	0.0004
Dieldrin	0.0093	0.5	0.4	0.023
Total				0.033
ICR				3.3×10^{-8}

Note: (1) Calculated for the most conservative target levels (Trespassing Adults).
-- = Toxicological indices are not currently available to calculate target levels protective of human health.

TABLE 5-8

SITE 2 - MANGROVE DISPOSAL SITE
INCREMENTAL LIFETIME CANCER RISKS AND HAZARD INDICES
ASSOCIATED WITH POTENTIAL EXPOSURE TO SEDIMENTS
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Chemicals of Potential Concern	Maximum Detected Concentration (mg/kg)	Trespassing Child Target Level (mg/kg)	Trespassing Adult Target Level (mg/kg)	Sediment Concentration/ Target Level(1)
Carcinogens				
4,4'-DDD	0.012	--	--	--
4,4'-DDE	0.022	24.6	17.0	0.001
4,4'-DDT	0.004	24.6	17.0	0.0002
Lead	50.1	--	--	--
Total				0.0043
ICR				4.3×10^{-9}

Note: (1) Calculated for the most conservative target levels (Trespassing Adults).
-- = Toxicological indices are not currently available to calculate target levels protective of human health.

TABLE 5-9

SITE 5 - ARMY CREMATOR DISPOSAL SITE
INCREMENTAL LIFETIME CANCER RISKS AND HAZARD INDICES
ASSOCIATED WITH POTENTIAL EXPOSURE TO SOILS
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Chemicals of Potential Concern	Maximum Detected Concentration (mg/kg)	Trespassing Child Target Level (mg/kg)	Trespassing Adult Target Level (mg/kg)	Future Workers Target Level (mg/kg)	Soil Concentration/ Target Level(1)
Carcinogens					
4,4'-DDD	0.180	--	--	--	--
4,4'-DDE	0.480	24.6	17.0	35.0	0.03
4,4'-DDT	3.5	24.6	17.0	35.0	0.21
beta-BHC	0.0011	4.6	3.2	7.5	0.0002
delta-BHC	0.0009	--	--	--	
Total					0.24
ICR					2.4×10^{-7}

Note: (1) Calculated for the most conservative target levels (Trespassing Adults).
-- = Toxicological indices are not currently available to calculate target levels protective of human health.

TABLE 5-10

SITE 6 - LANGLEY DRIVE DISPOSAL AREA
INCREMENTAL LIFETIME CANCER RISKS AND HAZARD INDICES
ASSOCIATED WITH POTENTIAL EXPOSURE TO SOILS
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Chemicals of Potential Concern	Maximum Detected Concentration (mg/kg)	Trespassing Child Target Level (mg/kg)	Trespassing Adult Target Level (mg/kg)	Soil Concentration/ Target Level(1)
Carcinogens				
Aldrin	0.00035	0.5	0.3	0.001
alpha BHC	0.0001	1.3	0.9	0.0001
beta BHC	0.0011	4.6	3.2	0.0003
delta BHC	0.0009	--	--	--
gamma BHC	0.0012	6.4	4.5	0.0003
Endosulfan II	0.00033	--	--	--
4,4'-DDD	0.0051	--	--	--
4,4'-DDE	0.003	24.6	17.0	0.0002
4,4'-DDT	0.0017	24.6	17.0	0.0001
Dieldrin	0.002	0.5	0.4	0.005
Benzene	0.001	280.0	200	0.00001
Arsenic	21.4	6.9	6.2	3.45
Lead	5,850	--	--	--
Benzo(a)pyrene	0.27	1.1	0.8	0.34
Benzo(a)anthracene	1.0	11.4	7.9	0.13
Benzo(b)fluoranthene	1.3	11.4	7.9	0.16
Benzo(k)fluoranthene	2.0	11.4	7.9	0.25
Chrysene	1.4	114.0	79.0	0.02
Dibenz(a,h)anthracene	0.45	1.1	0.8	0.56
Indeno(1,2,3-cd)pyrene	0.7	11.4	7.9	0.09
Total				5.0
ICR				5×10^{-6}

TABLE 5-10 (Continued)

SITE 6 - LANGLEY DRIVE DISPOSAL AREA
INCREMENTAL LIFETIME CANCER RISKS AND HAZARD INDICES
ASSOCIATED WITH POTENTIAL EXPOSURE TO SOILS
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Chemicals of Potential Concern	Maximum Detected Concentration (mg/kg)	Trespassing Child Target Level (mg/kg)	Trespassing Adult Target Level (mg/kg)	Soil Concentration/ Target Level(1)
Noncarcinogens				
Toluene	0.018	210,000	496,000	<0.001
Ethylbenzene	0.002	107,000	248,000	<0.001
Xylenes	0.008	(2)	(2)	--
Benzo(g,h,i)perylene	0.35	--	--	--
Fluoranthene	3.2	42,900	99,000	<0.001
Pyrene	2.1	32,000	74,000	<0.001
Copper	5,850	57,000	120,000	0.10
Zinc	3,350	465,000	(2)	--
Total				0.10
ICR				0.10

Note: (1) Calculated for the most conservative exposure scenario.
-- = Toxicological indices are not currently available to calculate target levels protective of human health.
(2) Value derived for the chemical exceed 1,000,000 mg/kg.

TABLE 5-11

SITE 10 - BUILDING 25 STORAGE AREA
INCREMENTAL LIFETIME CANCER RISKS AND HAZARD INDICES
ASSOCIATED WITH POTENTIAL EXPOSURE TO SOILS
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Chemicals of Potential Concern	Maximum Detected Concentration (mg/kg)	Trespassing Child Target Level (mg/kg)	Trespassing Adult Target Level (mg/kg)	Base Personnel Target Level (mg/kg)	Soil Concentration / Target Level(1)
Carcinogens					
4,4'-DDE	0.0037	24.6	17.0	12.0	0.0003
4,4'-DDT	0.0024	24.6	17.0	12.0	0.0002
Benzo(a)pyrene	0.35	1.1	0.8	0.6	0.58
Benzo(a)anthracene	0.51	11.4	7.9	6.0	0.09
Chrysene	0.80	114.0	79.0	60.0	0.01
Dibenz(a,h)anthracene	0.16	1.1	0.8	0.6	0.27
Indeno(1,2,3-cd)pyrene	0.34	11.4	7.9	6.0	0.06
Lead	61.1	--	--	--	--
Total					1.0
ICR					1×10^{-6}
Noncarcinogens					
Acenaphthene	0.084	64,000	149,000	87,600	<0.001
Anthracene	0.11	320,000	740,000	438,000	<0.001
Benzo(g,h,i)perylene	0.2	--	--	--	--
Fluoranthene	1.1	43,000	99,000	58,400	<0.001
Phenanthrene	0.49	--	--	--	--
Pyrene	0.81	32,000	74,000	43,800	<0.001
Zinc	202	465,000	(2)	500,000	0.004
Chromium	29.9	7,800	23,000	9,800	
Total					0.004
ICR					0.004

Note: (1) Calculated for the most conservative exposure scenarios. Carcinogens were evaluated using Base personnel. Noncarcinogens were evaluated using trespassing child target levels.
(2) Value in excess of 1×10^6 mg/kg.
-- = Toxicological indices are not currently available to calculate target levels protective of human health.

TABLE 5-12

SITE 14 - ENSENADA HONDA SHORELINE AND MANGROVES
INCREMENTAL LIFETIME CANCER RISKS AND HAZARD INDICES
ASSOCIATED WITH POTENTIAL EXPOSURE TO SEDIMENTS
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Chemicals of Potential Concern	Maximum Detected Concentration (mg/kg)	Trespassing Child Target Level (mg/kg)	Trespassing Adult Target Level (mg/kg)	Sediment Concentration/ Target Level(1)
Carcinogens				
Aldrin	0.0009	0.4	0.3	0.002
Alpha BHC	0.00007	--	--	--
4,4'-DDT	0.00058	24.6	17.0	0.00003
Total				0.002
ICR				2×10^{-9}

Note: (1) Calculated for the most conservative target levels (Trespassing Adults).
-- = Toxicological indices are not currently available to calculate target levels protective of human health.

TABLE 5-13

SITE 18 - PEST CONTROL SHOP AND SURROUNDING AREA
INCREMENTAL LIFETIME CANCER RISKS AND HAZARD INDICES
ASSOCIATED WITH POTENTIAL EXPOSURE TO SOILS
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Chemicals of Potential Concern	Maximum Detected Concentration (mg/kg)	Trespassing Child Target Level (mg/kg)	Trespassing Adult Target Level (mg/kg)	Base Personnel Target Level (mg/kg)	Soil Concentration/ Target Level(1)
Carcinogens					
alpha Chlordane	0.024	6.4	4.5	3.0	0.008
gamma Chlordane	0.023	6.4	4.5	3.0	0.008
4,4'-DDD	0.16	--	--	--	--
4,4'-DDE	0.38	24.6	17.0	12.0	0.03
4,4'-DDT	4.5	24.6	17.0	12.0	0.375
Benzo(a)pyrene	0.35	1.1	0.8	0.6	0.580
Benzo(a)anthracene	0.31	11.4	7.9	6.0	0.052
Benzo(b)fluoranthene	0.66	11.4	7.9	6.0	0.110
Chrysene	0.45	114.0	79.0	60.0	0.008
Arsenic	79.1	6.9	6.2	3.0	26.333
Total					27.5
ICR					2.8×10^{-5}
Noncarcinogens					
Fluoranthene	0.24	43,000	99,000	58,400	<0.001
Pyrene	0.3	32,000	74,000	43,800	<0.001
Total					<0.001
ICR					<0.001

Note: (1) Calculated for the most conservative exposure scenarios. Carcinogens were evaluated using Base personnel. Noncarcinogens were evaluated using trespassing child target levels.
-- = Toxicological indices are not currently available to calculate target levels protective of human health.

TABLE 5-14

SITE 18 - PEST CONTROL SHOP AND SURROUNDING AREA
INCREMENTAL LIFETIME CANCER RISKS AND HAZARD INDICES
ASSOCIATED WITH POTENTIAL EXPOSURE TO DITCH SEDIMENTS
NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

Chemicals of Potential Concern	Maximum Detected Concentration (mg/kg)	Trespassing Child Target Level (mg/kg)	Trespassing Adult Target Level (mg/kg)	Base Personnel Target Level (mg/kg)	Soil Concentration/ Target Level(1)
Carcinogens					
alpha-Chlordane	0.16	6.4	4.5	3.0	0.05
gamma-Chlordane	0.18	6.4	4.5	3.0	0.06
4,4'-DDD	4.7	--	--	--	--
4,4'-DDE	0.55	24.6	17.0	12.0	0.05
4,4'-DDT	0.49	24.6	17.0	12.0	0.04
Endosulfan I	0.23	--	--	--	--
Lead	83.8	--	--	--	--
Total					0.2
ICR					2×10^{-7}
Noncarcinogens					
Toluene	0.068	210,000.0	496,000.0	290,000.0	<0.001
Zinc	361.0	465,000.0	(2)	500,000.0	<0.001
Total					<0.001
HI					<0.001

Note: (1) Calculated for the most conservative exposure scenarios. Carcinogens were evaluated using Base personnel. Noncarcinogens were evaluated using trespassing child target levels.

-- = Toxicological indices are not currently available to calculate target levels protective of human health.

ingestion for trespassing children engaging in swimming activities were below USEPAs target risk range and 1.0 respectively.

5.5.5 Potential Ecological Effects

The potential for adverse ecological effects at NSRR appears to be limited.

Surface water samples obtained from Site 18 contained levels of pesticides well below freshwater or marine AWQC criteria.

Furthermore, sediments taken from Sites 2, 14, and 18 do not display COPC values in excess of the NOAA ER-L screening value with the exception of the inorganics lead (83.8 mg/kg), copper (133.0 mg/kg), and zinc (361 mg/kg) present in the Site 18 sediment sample (SED182). This sediment sample was taken in the drainage ditch behind the Pest Control Shop. Therefore, the effects on aquatic life, regardless of these exceedances, is most likely minimal. However, surface water bodies receiving ditch waters could potentially be affected by the presence of these chemicals.

5.6 Sources of Uncertainty

Uncertainties are encountered throughout the process of performing the risk assessment. This section discusses the sources of uncertainty involved with the following:

- Analytical data
- Potential contaminants of interest
- Exposure assessment
- Toxicity assessment
- Compounds not quantitatively evaluated

Uncertainties associated with this risk assessment are summarized in Table 5-15 and are discussed in detail below.

TABLE 5-15

SUMMARY OF UNCERTAINTIES IN THE RESULTS OF THE HUMAN HEALTH AND ECOLOGICAL ASSESSMENT NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

	Potential Magnitude for Over-Estimation of Risks	Potential Magnitude for Under-Estimation of Risks	Potential Magnitude for Over or Under-Estimation of Risks
Environmental Sampling and Analysis			
Sufficient samples may not have been taken to characterize the media being evaluated.			Moderate
Systematic or random errors in the chemical analysis may yield erroneous data.			Low
Toxicological Assessment			
Toxicological indices derived from high dose animal studies, extrapolated to low dose human exposure.	High		
Lack of promulgated toxicological indices for inhalation pathway.		Moderate	
Lack of data pertaining to terrestrial and aquatic ecological receptors.		High	
Exposure Assessment			
The standard assumptions regarding body weight, exposure period, life expectancy, population characteristics, and lifestyle may not be representative of the actual exposure situations.			Moderate
The use of the 90th and 95th percentile exposure inputs in the estimation of the RME.	Moderate		
The amount of media intake is assumed to be constant and representative of any actual exposure.			Low
Not evaluating the possible residential development of certain sites within Naval Station Roosevelt Roads		Low	
Compounds not quantitatively evaluated.		Low	

TABLE 5-15 (Continued)

SUMMARY OF UNCERTAINTIES IN THE RESULTS OF THE HUMAN HEALTH AND ECOLOGICAL ASSESSMENT NAVAL STATION ROOSEVELT ROADS, PUERTO RICO

	Potential Magnitude for Over-Estimation of Risks	Potential Magnitude for Under-Estimation of Risks	Potential Magnitude for Over or Under-Estimation of Risks
Exposure Assessment (continued)			
The use of total inorganic results for groundwater to evaluate potential chronic daily intakes associated with potable use.	High		
The amount of media intake is assumed to be constant and representative of any actual exposure.			Low
Risk Characterization			
Assumption of additivity in the quantitation of cancer risks without consideration of synergism, antagonism, promotion and initiation.			Moderate
Assumption of additivity in the estimation of systemic health effects without consideration of synergism, antagonism, etc.			Moderate
Additivity of risks by individual exposure pathways (dermal and ingestion and inhalation)			Low
Compounds not quantitatively evaluated.		Low	

Notes:

Low - Assumptions categorized as "low" may effect risk estimates by less than one order of magnitude.

Moderate - Assumptions categorized as "moderate" may effect estimates of risk by between one and two orders of magnitude.

High - Assumptions categorized as "high" may effect estimates of risk by more than two orders of magnitude.

Source: Risk Assessment Guidance for Superfund, Volume 1, Part A: Human Health Evaluation Manual. USEPA, 1989.

Analytical Data

The development of a risk assessment depends on the reliability of and uncertainties with the analytical data available to the risk assessor. Analytical data are limited by the precision and accuracy of the methods of analysis. For example, contract laboratory program methods of analysis have, in general, a precision of about plus or minus 50 percent depending upon the sample media and the presence of interfering compounds. A value of 100 µg/kg could be as high as 150 µg/kg or as low as 50 µg/kg. In addition, the statistical methods used to compile and analyze the data (detection frequencies) are subject to the overall uncertainty.

Furthermore, the number of sampling points at a given site from which analytical results are obtained can also directly affect the reliability of risk assessment. The potential effects on the overestimation or underestimation of risks is considered to be moderate.

Exposure Assessment

In performing exposure assessments, uncertainties arise from two main sources. First, uncertainties are inherent in estimating current or future potential human activity patterns at the site(s). Second, uncertainties arise in the estimation of chemical intakes resulting from contact by a receptor with a particular medium.

To estimate an intake, certain assumptions must be made about exposure events, exposure durations, and the corresponding assimilation of constituents by the receptor. Exposure factors have been generated by the scientific community and have undergone review by the USEPA. The USEPA has published an Exposure Factors Handbook (USEPA 1989a) which contains the best and latest values. These exposure factors have been derived from a range of values generated by studies of limited numbers of individuals. In all instances, values used in this risk assessment, scientific judgments, and conservative assumptions agree with those of the USEPA. Conservative assumptions, designed not to underestimate daily intakes, were employed throughout this risk assessment and are adequately protective of human health.

Despite the unlikely nature of future residential development at the sites comprising NSRR. Certain sites like the Pest Control Shop (Site 18) and surrounding areas or Site 10, Building 25 Storage Site could be developed for residential purposes. If the COPC 4,4'-DDT were evaluated assuming the future residential development of these properties the target level protective of the 10^{-6} risk level would be 4.0 mg/kg. The target level derived for the future

potential exposure of resident children (15 kg) is approximately 3.0 times more conservative than the target level derived for base personnel, the receptor used in the evaluation of Sites 10 and 18. If future residential development were to occur, the corresponding ICR value for these sites would be 3×10^{-6} and 8×10^{-5}, respectively. These values are still within USEPA's target risk range. Corresponding HI values for these sites would also remain below 1.0 indicating that the potential for adverse systemic health effects is small. The potential for underestimating potential human health risks by not evaluating the future residential development of certain sites at NSRR is, therefore, considered to be low.

Toxicological Assessment

In making quantitative estimates of the toxicity of varying dosages of compounds to human receptors, uncertainties arise from two sources. First, data on human exposure and the subsequent effects are usually insufficient, if they are at all available. Human exposure data usually lack adequate concentration estimations and suffer from inherent temporal variability. Therefore, animal studies are often used and new uncertainties arise from the process of extrapolating animal results to humans. Second, to obtain observable effects with a manageable number of experimental subjects, high doses of a compound are often used. In this situation, a high dose means that high exposures are used in the experiment with respect to most environmental exposures. Therefore, when applying the results of the animal experiment to the human condition, the effects at the high doses must be extrapolated to approximate effects at lower doses.

In extrapolating effects from high doses in animals to low doses in people, scientific judgment and conservative assumptions are employed. In selecting animal studies for use in dose-response calculations, the following factors are considered:

- Studies are preferred where the animal closely mimics human pharmacokinetics.
- Studies are preferred where dose intake most closely mimics the intake route and duration for humans.
- Studies are preferred which demonstrate the most sensitive response to the compound in question.

For compounds believed to cause threshold effects (i.e., noncarcinogens) safety factors are employed in the extrapolation of effects from animals to humans and from high doses to low doses.

The use of conservative assumptions, results in quantitative indices of toxicity that are not expected to underestimate potential toxic effects, but may overestimate these effects by an order of magnitude or more.

Compounds Not Quantitatively Evaluated

The following compounds were not quantitatively evaluated because of the unavailability of information on oral toxicity:

- 4,4'-DDD
- Endrin aldehyde
- delta-BHC
- Endosulfan I
- Endosulfan II
- Endosulfan Sulfate
- Acenaphthylene
- Benzo(g,h,i)perylene
- Phenanthrene
- Copper
- Lead

Although these constituents were not quantitatively assessed, this risk assessment has been performed using maximum COPC concentrations, conservative exposure scenarios, and exposure factors.

6.0 CONCLUSIONS AND RECOMMENDATIONS

The discussions of this section refer only to the Sites 1, 2, 5, 6, 10, 14 and 18 which are under review for design of an RFI (Section 1.1.3.1). Section 1.1.3.2 (Relief From RFI Design - Site 13) describes the disposition of the UST/fueling areas, which disposition is supported by the photo-interpretation results (Section 4.1.7). The data developed for the sites mentioned in Section 1.1.3.3 (Non-RFI Information - Sites 7, 16 and 21) have been prepared for submission, or already have been submitted, to the appropriate programs.

6.1 Observations and Conclusions

6.1.1 General Description

The general description of the relevant sites involves review of the significant characteristics of topography, hydrology, physical and chemical geohydrology, and operational considerations.

6.1.1.1 Site 1 - Quebrada Disposal Site, Vieques Island

Topography

The field program has provided the following descriptions of the general appearance of Site 1:

- Detailed location of the disposal areas or practices is not available from historical documents or from examination of the site.

- The restricted traverse of the site during the field program did not allow complete, horizontal mapping of the disposal area.

- However, the information cited in Sections 1.2.3.1 and 4.1.1 indicates that the site was not an engineered or constructed feature, but rather was subjected to general scattering of debris across a wide area of the land surface; this deduction accords with the experience of the field teams, who found no evidence of subsurface disposal during sampling.

The two significant findings of the field program regarding the topographic configuration of the site are that the disposed material is randomly scattered and apparently entirely exposed at the surface, and that the overgrowth of low vegetation is exceptionally dense.

Hydrology

The bottom of the ravine (quebrada) below the disposed material was found to be dry during the field program. The appearance of the streambed indicated that no flowing water could be expected except during a period of intense precipitation; the light to heavy precipitation experienced during the field program did not produce a continuous flow in the ravine (even during and shortly after storms). Therefore, the flow of surface water can be largely neglected in considering further action at this site; only the steepness of the ravine profile would be of concern as a control to overland movement of liquids and solids.

Physical Geohydrology

The three wells at the site were found and examined. No immediate need for repair was noted. The significant findings and observations on the groundwater monitoring system are:

- The general elevation of the water-table had dropped sufficiently since installation of the wells that no usable water could be found in the wells.

- The configuration of the stations in relation to the disposed material (Figures 1-4 and 4-1) indicates that the wells are displaced downslope from the most notable area of debris, and that the wells are appropriately placed downgradient of the area subjected to disposal (field observations also indicate that no other positions in the area would provide significantly better advantage for monitoring the water table).

Chemical Geohydrology

Analysis of inorganic parameters indicates no distinctly abnormal concentrations in any medium. Synthetic organic compounds are present at the site in all media tested; however, the concentrations found do not indicate that these compounds are of significant environmental interest.

Operational Considerations

Site 1 is characterized (1) by steep slopes of the ravine walls and a steep profile of the (normally dry) streambed in the ravine, and (2) by an exceptionally dense overgrowth of low vegetation. These conditions make effective movement around the site impossible without extensive land-clearing. Further mapping of the site, and any further investigation or remedial action at the site, would unavoidably involve extensive land-clearing in highly unfavorable terrain. Extensive land-clearing, given the surface-scattering of debris, would necessarily include displacement of virtually all of the remaining debris, possibly requiring disposal under a regulated program. An endangered/protected species of insect occupies this area; land-clearing of usable proportions could not proceed without a detailed survey of the nests of these insects and relocation of those nests.

6.1.1.2 Site 2 - Mangrove Disposal Site, Vieques Island

Topography

The field program has provided the following descriptions of the general appearance of Site 2:

- Detailed location of the disposal areas or practices is not available from historical documents or from examination of the site.

- The examination of the site during the field program did not allow complete, horizontal mapping of the disposal area.

- However, the information cited in Sections 1.2.3.2 and 4.1.2 indicates that the site was not an engineered or constructed feature, but rather was subjected to general scattering of debris across the land surface; this deduction accords with the experience of the field teams, who found no evidence of subsurface disposal during sampling.

The most significant findings of the field program regarding the topographic configuration of the site are that the disposal material is sparsely and randomly scattered, and is apparently entirely exposed at the surface.

Hydrology

The low-lying disposal area is surrounded on three sides by open water. There are abundant indications in the field that the site is frequently flooded. This flooding can be expected to effect some additional dispersal of materials at the site.

Physical Geohydrology

The geohydrologic system of the disposal area is entirely controlled by the surrounding, tidal surface waters. Groundwater, as a potable resource, is not a relevant medium at Site 2 because of the encapsulation by marine environments.

Chemical Geohydrology

Analysis of inorganic parameters indicates no distinctly abnormal concentrations in any medium. Synthetic organic compounds are present at the site in all media tested; however, the concentrations found do not indicate that these compounds are of significant environmental interest. The analyses of disposal material (tar or asphaltic oil) did not indicate a dominant environmental influence by that material.

Operational Considerations

The area is moderately vegetated; further investigation can be conducted with minimal disturbance of this cover, but remedial actions may require land-clearing and revegetation. The disposal material is scattered across the surface of small areas, and relatively accessible.

6.1.1.3 Site 5 - Army Cremator Disposal Area

Topography

The field program has provided the following descriptions of the general appearance of Site 5:

- Detailed location of the disposal areas or practices is not available from historical documents.

- The photo-interpretation and map analysis (Section 4.1.3) of the disposal areas and features were verified by the field investigation (Section 4.2).

- The restricted traverses of the site during the field program did not allow complete, horizontal mapping of the disposal area; however, a high confidence in the mapping described in Sections 4.1.3 and 4.2 is justified by the field evidence.

- The available information indicates that the site included numerous engineered or constructed features; this agrees with the observations of the field team.

The most significant findings of the field program regarding the topographic configuration of the site are that the disposal material is mostly buried with some scattering at the surface, and that the overgrowth of vegetation is exceptionally dense.

Hydrology

There are no established streams within Site 5. The dominant hydrologic feature associated with the site is the mangrove swamp of Site 14.

Physical Geohydrology

There are insufficient data for discussion of the geohydrology of Site 5; only well 05GW01 could be found during the Supplemental Investigation.

Chemical Geohydrology

The single data station found at Site 5 provides information on background conditions only. Nothing significant appears in these data, except the general appearance across NSRR of pesticides.

Operational Considerations

Site 5 is characterized (1) by steep slopes on the sides of the knoll, and (2) by an exceptionally dense overgrowth of low vegetation. These conditions make effective movement around the site impossible without extensive land-clearing, effectively of the entire knoll. Further mapping of the site, and any further investigation or remedial action at the site, would

necessarily involve extensive land-clearing in unfavorable terrain. Extensive land-clearing, given the surface-scattering of some debris, would include displacement of those debris, requiring possible disposal under a regulated program. Land-clearing on an appropriate scale would also involve extensive siltation in the nearby, protected environment of the mangrove swamp.

6.1.1.4 Site 6 - Langley Drive Disposal Area

Topography

The field program has provided the following descriptions of the general appearance of Site 6:

- Detailed location of the disposal area or practices is not available from historical documents.

- The photo-interpretation and map analysis (Section 4.1.4) of the disposal areas and features were verified by the field investigation.

- The traverse of the site during the field program did not allow complete, horizontal mapping of the disposal area; however, a high confidence in the mapping described in Sections 4.1.4 and presented on Figure 4-4 is justified by the field evidence.

- The available information indicates that the site included a very simply engineered or constructed feature (elevation of a level land surface by grading of disposal fill); this agrees with the observations of the field team.

The most significant findings of the field program regarding the topographic configuration of the site are that the disposal material is mostly buried in the shallow soil with some scattering at the surface, and that the overgrowth of vegetation is exceptionally dense.

Hydrology

There are no established streams within Site 6. The dominant hydrologic feature associated with the site is the mangrove swamp of Site 14.

Physical Geohydrology

There are insufficient data for discussion of the geohydrology of Site 6; there is only the single station, 06GW01, for this site.

Chemical Geohydrology

The single data station at Site 6 provides information on background conditions only. Nothing significant appears in these data with no contaminants of concern identified. However, the proximity of this site to the marine environment of the harbor indicates that groundwater, as a potable resource, is not a relevant medium.

Operational Considerations

Site 6 is characterized by an exceptionally dense overgrowth of low vegetation on boggy ground. This makes effective movement around the site impossible without extensive land-clearing, effectively of the entire area between the road and the inundated (tidal) perimeter of the mangrove swamp. Further mapping of the site, and any further investigation or remedial action at the site, would necessarily involve extensive land-clearing in highly unfavorable terrain. Extensive land-clearing, given the shallow burial and surface-scattering of debris, would unavoidably include displacement of those debris, requiring possible disposal under a regulated program. Land clearing on an appropriate scale would also likely result in extensive siltation in the nearby, protected environment of the mangrove swamp.

6.1.1.5 Site 10 - Building 25 Storage Area

Topography

The surface area of Site 10 has been extensively reworked by construction and base operations. No distinct features of Building 25 remain except the foundation pad on which heavy equipment is now occasionally parked.

Hydrology

There are no surface streams at Site 10. There is some internal drainage to the north and northeast side of the site, in a vegetated area.

Physical Geohydrology

The physical geohydrology of Site 10 was not addressed in this program.

Chemical Geohydrology

The chemical geohydrology of Site 10 was not addressed in this program.

Operational Considerations

The current use of the land-surface of Site 10 (for storage and heavy maintenance) indicates that further investigation or any remedial action would disrupt base support operations. Further investigation of the area around Building 25 would yield results that could not be defensibly associated with operations at Building 25, given the extent of current activities.

6.1.1.6 Site 14 - Ensenada Honda Shoreline and Mangroves

Topography

Site 14 is a coastal margin containing a mangrove swamp.

Hydrology

The hydrologic regime of Site 14 is controlled by the semidiurnal tides, embayment circulation and response to storms of oceanic waters in the harbor.

Physical Geohydrology

The physical geohydrology of Site 14 (as a marine environment) is not relevant as a potable reserve.

Chemical Geohydrology

The chemical geohydrology of Site 14 (as a marine environment) is not relevant as a potable reserve.

Operational Considerations

There are no feasible remedial actions applicable to the mangrove swamp of Site 14, except monitoring of natural processes. Any extensive engineering action would completely destroy the environment of the swamp.

6.1.1.7 Site 18 - Building 128, Pest Control Shop and Surrounding Area

Topography

The immediate vicinity of Building 128 is cleared and approximately level, with a hardstand occupying about half of the site.

Hydrology

The significant hydrologic features of Site 18 are a drainage ditch paralleling Forrestal Drive and a wetland west of the site.

Physical Geohydrology

The water-table is shallow, at about three to nine feet below ground. The near-surface flow is to the west, through colluvial material having hydraulic conductivities ranging from about 0.14 to 1.3 ft/d.

Chemical Geohydrology

The results of analyses of inorganic compounds do not indicate an impression of dissolved species on the expectable groundwater quality. The results of analyses of organic compounds similarly indicate no general distribution of those compounds in the groundwater. There is a minor presence of pesticide in the soil, surface water and sediment of Site 18.

Operational Considerations

Site 18 is open to investigation and remedial operations between the tree line and Forrestal Drive. Operations beyond the tree line would require extensive land-clearing.

6.1.2 Contaminant Distribution

Disposed materials are exposed at Sites 1, 2, 5 and 6; however, there is no strong evidence that an outfall of contaminant constituents has migrated from the disposed materials in any examined medium. Disposed materials are not apparent at Sites 10, 14 and 18; also, there is no strong evidence (from the absence of contaminants of concern from samples taken within, and downslope and downgradient of the disposal areas) that an outfall of contaminant constituents has migrated from the expected disposal areas in any examined medium.

6.1.3 Risk Evaluation

Cancer risk values (ICRs) and hazard indices (HIs) for noncarcinogenic chemicals of concern were derived using conservative exposure estimates and USEPA promulgated exposure factors for each site at NSRR.

ICR values were compared to USEPA's target risk range (10^{-6} to 10^{-4}). The target risk range represents USEPA's opinion on generally acceptable cancer risk values. The target risk range is also used by the Agency in the selection of remedies for the Superfund program. ICR values below the lower end of USEPA's target risk range (10^{-6}) do not generally require remediation. ICRs above the upper end of the target risk range (10^{-4}) generally do require remediation to protect an exposed individual and reduce the risk to a value which falls within the 10^{-6} to 10^{-4} risk range.

HI values, derived for noncarcinogenic chemicals of concern greater than or equal to 1.0, require remediation. HI values below 1.0 suggest that systemic health effects will not occur subsequent to exposure even by sensitive populations, and do not generally require remediation.

Site 1 - Quebrada Disposal Site

The Quebrada Disposal Site, Vieques Island was evaluated by assuming that an older child (6 to 15 years of age) would access the quebrada 100 days per year over a 9-year exposure duration. Chemicals of potential concern (COPCs) at Site 1 were PCB-1260 (0.025 mg/kg) and toluene (0.052 mg/kg). The corresponding incremental lifetime cancer risk (ICR) was 2.5×10^{-8}, which falls below USEPA target risk range of 10^{-6} to 10^{-4}. A hazard index (HI) value of <0.001 was also derived, suggesting that adverse systemic health effects would not occur subsequent to exposure even in sensitive populations.

Site 2 - Mangrove Disposal Site

The Mangrove Disposal Site was evaluated by assuming that older children and adults would access the site. Again, exposure durations of 100 days per year were used in the derivation of target levels. COPCs for Site 2 soils include alpha-Chlordane, gamma-Chlordane, 4,4'-DDT, 4,4'-DDD, 4,4'-DDE and Dieldrin. These chemicals were detected at relatively low levels. A corresponding ICR value of 3.3×10^{-8} was derived for the most conservative exposure scenario and human receptor (trespassing adults). This ICR value is below USEPA's target risk range of 10^{-6} to 10^{-4}. The HI value was not derived because noncarcinogenic chemicals were not retained as COPCs.

COPCs in Site 2 sediments include the DDT-series pesticides (4,4'-DDT, 4,4'-DDD and 4,4'-DDE) and lead.

The ICR value derived for Site 2 sediments considered trespassing older children and adults, and was 4.3×10^{-9}. Again, noncarcinogenic chemicals were not retained as COPCs.

The total site risk associated with dermal contact and accidental ingestion of soils and sediments was derived by summing the ICR values for each medium. The total site ICR value was approximately 4×10^{-8}, which is below USEPA's target risk range.

Maximum Site 2 sediment concentrations of COPCs did not exceed the NOAA screening value ER-L; therefore, potential ecological effects are not expected.

Site 5 - Army Cremator Disposal Area

The Army Cremator Disposal Area was evaluated by assuming that trespassing children, trespassing adults and future workers could be exposed to COPCs detected in soil samples. COPCs at Site 5 include the DDT-series pesticides, beta BHC and delta BHC. The most conservative ICR value 2.4×10^{-7} was derived for the adult trespasser who could be potentially exposed 100 days per year over a 30-year period.

The HI value was not derived because noncarcinogenic chemicals were not retained as COPCs.

Site 6 - Langley Drive Disposal Area

The Langley Drive Disposal Area was evaluated assuming that trespassing children and adults would access the site 100 days per year for 9 and 30 years respectively. COPCs selected for Site 6 include aldrin, alpha-BHC, beta-BHC, delta-BHC, gamma-BHC, Endosulfan II, the DDT-series, Dieldrin, benzene, arsenic, lead, PAHs, toluene, ethylbenzene, xylenes, copper and zinc. The corresponding ICR value derived for trespassing adults (the most conservative scenario) was 5×10^{-6}, which falls within USEPA's target risk range of 10^{-6} to 10^{-4}.

An HI value of 0.1 was derived for the most conservative scenario (trespassing children). This value is below 1.0, suggesting that noncarcinogenic health effects would not occur subsequent to exposure.

Site 10 - Building 25 Storage Area

The Building 25 Storage Area was evaluated by assuming that trespassing children, trespassing adults and Base Personnel could be exposed to COPCs detected in soil samples. COPCs selected for site 10 soils include 4,4'-DDT, 4,4'-DDE, PAHs lead, zinc and chromium. The corresponding ICR value derived for the most conservative exposure scenario (Base Personnel) was 1×10^{-6}, which is equal to the lower value of USEPA's target risk range.

The HI value was derived for a trespassing child which was the most conservative scenario for noncarcinogenic COPCs by virtue of a shorter averaging time. The HI value (0.004) was below 1.0, suggesting that the occurrence of systemic health effects are unlikely subsequent to exposure.

Site 14 - Ensenada Honda Shoreline and Mangroves

The Ensenada Honda Shoreline and Mangroves were evaluated by assuming that trespassing children and adults would be exposed to COPCs in sediment samples by accidental ingestion and dermal contact. Contacting sediments along the Ensenada Honda Shoreline and in the Mangrove swamps is unlikely because of the limited access to these areas and their physical characteristics. Trespassing children and adults were, however, evaluated for conservative consistency with other sites being evaluated at NSRR.

Noncarcinogenic chemicals were not retained as COPCs because of their occurrence in background sediment samples; therefore, an HI value was not derived.

COPCs retained at Site 14 include aldrin, alpha-BHC and 4,4'-DDT. These chemicals were present as a result of pesticide application processes and not because of the reported fuel spill. The corresponding ICR value was 2×10^{-9}, which falls well below USEPA's target risk range.

Furthermore, COPC concentrations in Site 14 sediments do not exceed the NOAA ER-L screening values, suggesting that ecological effects associated with affected sediments are minimal.

Site 18 - Building 128, Pest Control Shop and Surrounding Area

The Pest Control Shop and Surrounding Area was evaluated by assuming that trespassing children, adults and Base Personnel would be exposed to COPCs detected in site soils and ditch sediments. COPCs in Site 18 soils include alpha and gamma-chlordane, the DDT-series pesticides, PAHs and arsenic. The corresponding ICR value for Site 18 was 2.8×10^{-5}, primarily due to the presence of arsenic (96% of the total ICR). The HI value for Site 18 soils was <0.001.

COPCs for Site 18 sediments include alpha- and gamma- chlordane, the DDT-series pesticides, endosulfan I, toluene, lead and zinc. The corresponding ICR and HI values were 2×10^{-7} and <0.001 respectively.

The total site ICR and HI values were derived by summing the ICR and HI values generated for soil and sediment exposure. These values were 2.8×10^{-5} and <0.01 respectively. The ICR

value falls within USEPA's 10^{-6} to 10^{-4} target risk range. The HI is below 1.0, suggesting that systemic health effects would not occur subsequent to multiple media exposure.

Site 18 sediment sample results for lead, zinc and copper exceed the NOAA ER-L sediment screening criteria, but not the ER-M values. This suggests that the potential for ecological effects in the ditch is possible.

6.2 Recommendations

Considering the information presented in Section 6.1, the following recommendations are appropriate to the disposition of Sites 1, 2, 5, 6, 10, 14 and 18 under design of an RFI:

Site 1 - Quebrada Disposal Site, Vieques Island

Adequate information is available for characterization of Site 1. Further investigation of site conditions is unnecessary, considering the absence of risk calculated from the available information. Human health risks at Site 1 are limited due to the inaccessible nature of the site and the limited potential for future development. ICR values for trespassing children were below USEPA's target risk range of 10^{-6} to 10^{-4}, and HI values indicated that the potential for systemic health effects subsequent to exposure are not likely to occur.

Site 2 - Mangrove Disposal Site, Vieques Island

Adequate information is available for characterization of Site 2. Adult and children trespassers accessing Site 2 during fishing or crabbing activities could potentially contact COPCs detected in Site 2 soil and sediment samples. ICR values and HI for both receptor groups are below USEPA's target risk range and unity (1.0), respectively. Future development of Site 2 is unlikely due to the physical characteristics of the site. Ecological effects associated with aquatic organism exposure to sediments are unlikely because maximum sediment COPC concentrations fall below NOAA's ER-L sediment screening values. Further investigation of site conditions is unnecessary, considering the absence of risk calculated from the available information.

Site 5 - Army Cremator Disposal Area

Adequate information is available for characterization of Site 5. Further investigation of site conditions is unnecessary, considering the absence of risk calculated from the available information. Human health risks at Site 5 are currently limited because of the inaccessibility of the site. Because of the location of Site 5, however, future development of the site could potentially occur. Adult and child trespassers and future workers contacting Site 5 soils produce ICR values below the USEPA target risk range of 10^{-6} to 10^{-4}. Noncarcinogenic COPCs were not retained as COPCs at Site 5; therefore, an HI value was not derived and noncarcinogenic adverse human health effects were not expected.

Site 6 - Langley Drive Disposal Area

Adequate information is available for characterization of Site 6. Further investigation of site conditions is unnecessary, considering the absence of risk calculated from the available information. Because of the relatively inaccessible nature of Site 6 and the physical characteristics of the site, current and future potential for human exposure is limited. For the sake of conservatism, adult and child trespassers were evaluated. The corresponding ICR value was 5×10^{-6}, which falls within USEPA's target risk range, and indicates acceptable environmental conditions. The HI value was 0.1, suggesting that systemic health effects would not occur subsequent to exposure.

Site 10 - Building 25 Storage Area

Adequate information is available for characterization of Site 10. Further investigation of site conditions is unnecessary, considering the absence of risk calculated from the available information. Human health risks associated with potential exposure at Site 10 were evaluated by assuming that adult and child trespassers and Base employees could potentially be exposed to COPCs detected in soil samples. The ICR value was 1×10^{-6} which equals the lower value of USEPA's target risk range, and indicates acceptable environmental conditions. The corresponding HI value was 0.004, suggesting that systemic health effects will not occur subsequent to exposure even in sensitive populations.

Site 14 - Ensenada Honda Shoreline and Mangroves

Adequate information is available for characterization of Site 14. Further investigation of site conditions is unnecessary, considering the absence of risk calculated from the available information. Human health effects associated with site 14 are limited because of the current limited access and the unlikeliness of future development in the Ensenada Honda Shoreline and Mangroves. For the sake of conservatism, adult and child trespassers were evaluated to determine the risk associated with potential dermal contact and incidental ingestion of sediments. Adult and child trespassers would contact the COPCs in sediments during fishing or crabbing activities. The ICR value was 2×10^{-9} which is well below USEPA's target risk range. The corresponding HI value was <0.001, suggesting that noncarcinogenic human health effects would be unlikely. Sediment COPC values were also compared to NOAA's sediment screening values. Sediment COPC concentrations did not exceed their corresponding ER-L value suggesting that adverse effects on aquatic organisms would not occur.

Site 18 - Building 128, Pest Control Shop and Surrounding Area

Adequate information is available for characterization of Site 18. Trespassing children, trespassing adults and Base personnel accessing Site 18 produced ICR values equal to or below 2.8×10^{-5}, which falls within USEPA's target risk range of 10^{-6} to 10^{-4}. The corresponding HI value was <0.001, suggesting that noncarcinogenic adverse health effects would not occur subsequent to exposure. Trespassing children, adults and Base personnel could also be exposed to COPCs detected in ditch sediments. The corresponding ICR was 2×10^{-7}, which falls below USEPA's target risk range. The sediment HI value was <0.001 suggesting that systemic health effects would not occur subsequent to sediment exposures. Future residential development of Site 18 was also considered as part of the uncertainties section of the human health evaluation. The corresponding ICR value was 8×10^{-5}, which again falls within USEPA's target risk range. Systemic health effects were not expected upon future residential development of the site. Ditch sediment COPCs lead, copper, and zinc did exceed their corresponding NOAA sediment screening ER-L values, suggesting that adverse effects on aquatic organisms in the ditch might become possible if a perennial surface water environment were to become established in the ditch; this condition does not currently exist and is highly unlikely as a future case. However, the effects on the ecology of the Site 18 area and NSRR are probably minimal. Further investigation of site conditions is unnecessary, considering the absence of risk calculated from the available information.

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